Highway Plan Reading Volume II (English Version) 2013 Edition

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Technology Transfer and Training

DOTD Employee Training Manual

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PREFACE

The objective of Highway Plan Reading Volume II is to convey to each student the information necessary to accurately read and interpret the following Highway Plan Reading materials.

- Special Detail Sheets
- Drainage Map Sheets
- Subgrade Soil Survey Sheets
- Standard Plan Sheets
- Box Culvert Sheets
- Bridge Plan Sheets
- Summary Sheets

The design of Highway Plan Reading Volume II takes into account the DOTD and contract personnel whose duties may involve the reading and interpretation of highway plans.

COURSE DESIGN

Highway Plan Reading Volume II is a self-paced instructional study course with information presented in clear, easy to read topics, where each topic adds to the previous one. This method instructs by giving relatively small pieces of information followed by a series of questions.

Writing the answers in the spaces provided, and then comparing them to the answer key not only produces an excellent set of review notes, it reinforces the material, enabling students to retain it for a longer period.
Students are encouraged to immediately correct any mistakes, then, reread the material until they understand it. Additional review questions at the end of each chapter help students assess their understanding of the material.

COURSE DESIGN (*continued)*

Highway Plan Reading Volume II is a seven-chapter manual of instruction with two appendices, a glossary of terms, and the answers to the chapter questions. A Plan Book accompanies the manual. Contained within the Plan Book are reduced-size plan sheets taken from actual plan sets used by the Louisiana Department of Transportation and Development. To illustrate certain features, the Plan Book integrates sheets taken from several different plan sets, some of which are modified to enhance this course.

Unless otherwise indicated, all references to plan sheets examine the material found within the Plan Book. To save reproduction costs, the entire set of plans is not included in the Plan Book.

After completing Highway Plan Reading Volume II, students are encouraged to take the course examination, the results of which will indicate how well each has learned to read and interpret plans.

Students are also urged to rework any portions of the course that present difficulty on the exam.

Before starting this course, check to see that a complete set of training materials is available, it should include the following:

- Volume II of the Highway Plan Reading course (this manual)
- An 11” x 17” Plan Book containing reduced size plan sheets for Highway Plan Reading Volumes I & II

  ** Note: The Plan Book is the same for Volume I and II.*

Although not required for this course, the following publications provide additional reference material.

- The latest edition of the Louisiana Standard Specifications for Road and Bridges
- Highway Specifications Workbook
- Roadway Plan Preparation Manual
- Bridge Plan Preparation Manual

CREDITS

This 2013 copy of Highway Plan Reading Volume II is the third edition. It is a revision of the original course developed in 1968, and rewritten in 2002.

John Dean of LSU/LTRC revised this manual with contributions from Karen Cordell, LTRC Construction Materials Training Staff Manager and Cindy Twiner, the LTRC Structured Training Director. Michael Boudreaux, Technology Transfer and Implementation Engineer contributed to editing and review.

CHAPTER 7
SPECIAL DETAILS SHEETS

INTRODUCTION

Chapter 6 covered Typical Sections and Details. However, many non-typical, specialty construction processes or procedures occur during the building of a highway. These items are termed **SPECIAL DETAILS,** and are constructed at specific locations throughout the project.

Special Details contain construction items that are **NOT typical, yet specific to the individual project.** The project still has *typical* sections and details covering *typical* construction practices.

Remember, Special Details like Special Provisions (Chapter One) vary with each project, making each Special Detail drawing unique to a particular project plan set.

This chapter discusses Special Details associated with **turnouts, rice levees, irrigation canals, and headlands**.

Illustrations within this chapter are just a few representations of many possible Special Details, and should not be considered an exhaustive set of examples.

Almost any part of a construction project that is special or nonstandard is considered a Special Detail, and is usually accompanied with a Special Detail drawing.

Throughout the chapter, consecutive **TOPIC** numbers indicate various facets of information pertaining to Special Detail sheets. Occasionally, topic numbers will reference one another.

As in previous chapters, review questions relating to the subject information appear periodically. Complete each question, as they will become useful study guide material.

TURNOUTS

7-1. Chapter 6 briefly discussed the department's standard plan sets as they relate to typical "driveway to roadway" access. Similar to driveways, **turnouts** permit traffic to turn on and off the main road, and are required where ***side roads connect to a highway***. These require special construction techniques, as each connection is unique. **Figure 7-1** is an example of a special detail specific to this particular turnout. Note the following items.

- The bearing of the main road is written on the centerline.
- The width of each traffic lane.
- Centerlines depicting the intersection of the turnout and main roadway.
- Arcs depicting the location of the turnouts.
- The quantity of each material required to build the base course and travel lane surface.
- Dimensions (distances).
- Station numbers.

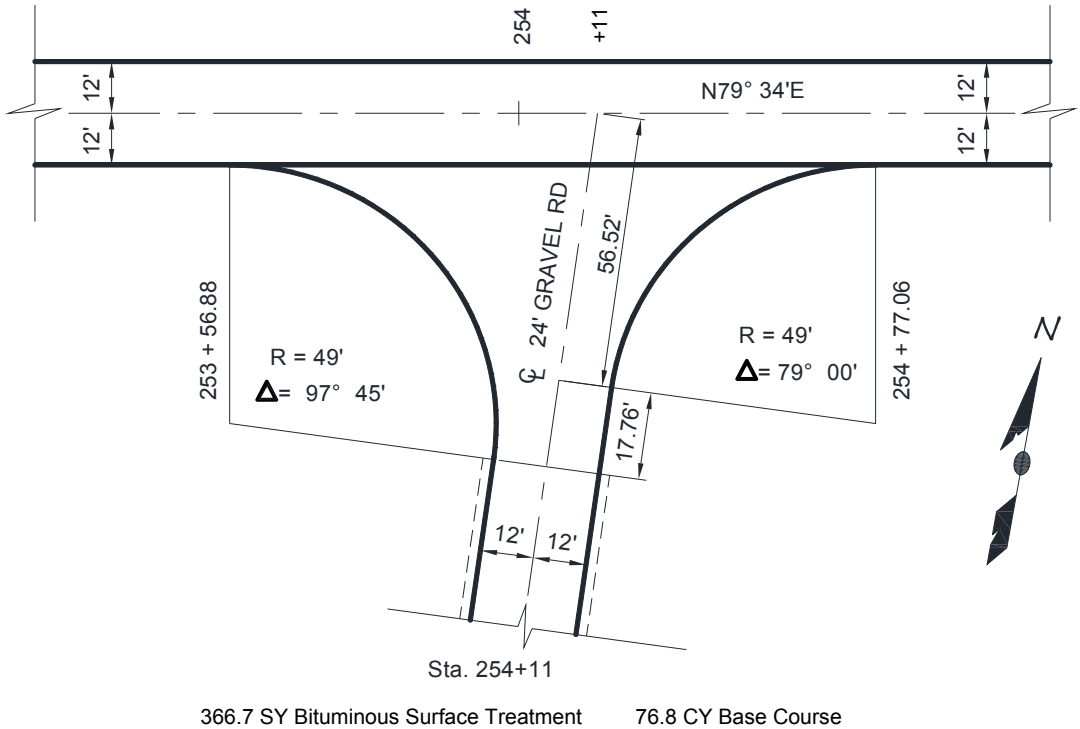


Figure 7-1: DETAIL OF A TURNOUT

7-1. *(continued)*

Review Figure 7-1, answer the following questions, and record the correct answer in the blank provided.

a. The centerline of the turnout meets the centerline of the main road at Station _____.

b. How many cubic yards (CY) of base course are required? _____

c. How many square yards (SY) of bituminous surface treatment will this turnout require? _____

d. How wide is the turnout where it connects to the side of the roadway? _____ *(Hint: subtract the lesser Station number from the greater Station number)*

e. What is the bearing of the main roadway? _____

f. Measure along the centerline of the gravel road. The turnout begins _____ feet south of the intersection of the centerlines. (*Hint: 2 dimensions must be added together*)

g. Write a description of the road that intersects the main highway.

_____

7-2. Below, **Figure 7-2** shows the right half of the turnout from Figure 7-1. Notice the measurements and the location of specific points.

- Point ① is a given point of reference (Station 254 + 77.06)
- Point ② is 49′ south of Point ① on line Ⓐ perpendicular to the centerline of the main road.
- Point ③ is the starting point for an arc that forms the curved portion of the turnout. Notice that Point ③ is at the end of a 49′ radius line originating from Point ②.

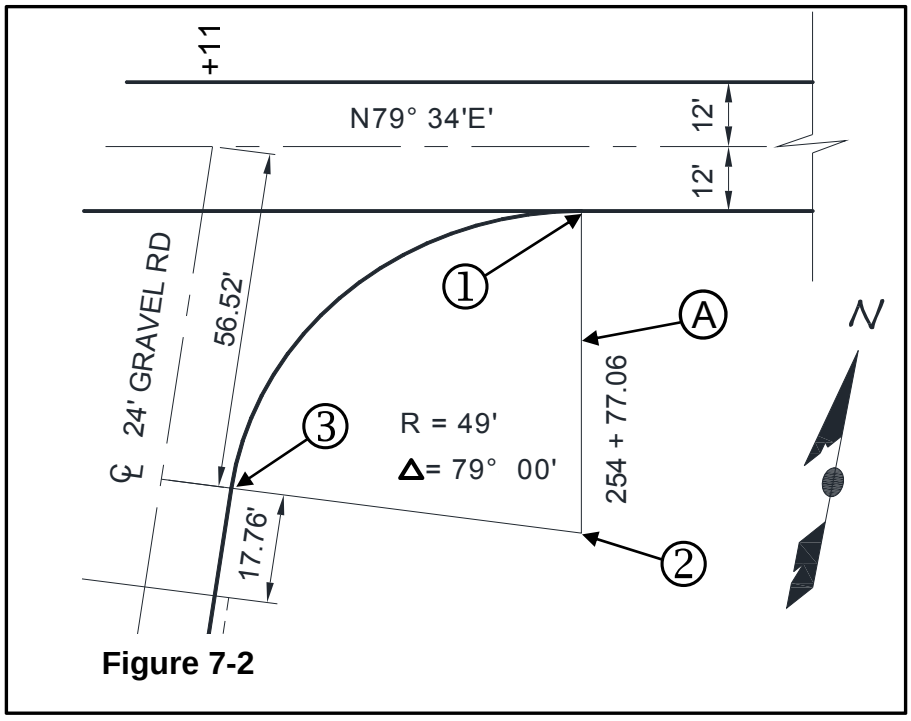


Figure 7-2

Refer to Figure 7-2 as a guide, and then use Figure 7-1 to answer the following questions with regard to the curved part of the turnout, **WEST** of the gravel road.

a. The curved portion begins at Station _____.

b. The radius of the curve is _____.

c. The angle between the radii is _____.

7-2. *(continued)*

Refer again to Figure 7-1; notice the **dashed lines** on the turnout. These indicate the **shoulders** of the existing gravel road.

d. What is the width of the gravel road? _____

IRRIGATION CANALS AND RICE LEVEES

7-3. Below is the symbol used to represent a **single-line rice levee**. Plan and Profile Sheets often show this "levee" symbol."

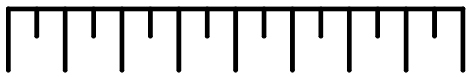


Figure 7-3 on the next page shows a cross-section of a **single-line rice levee**, and a cross-section of an **irrigation canal**.

- A **single-line rice levee** keeps the water in the flooded field from draining into the Right-of-Way.

- An **irrigation canal** carries water for irrigation purposes.

7-3. *(continued)*

An **irrigation canal** and a **rice levee** are very *similar* in construction. Look carefully at Figure 7-3. Compare the Special Details associated with the irrigation canal and the levee. The canal looks like a ditch between two levees.

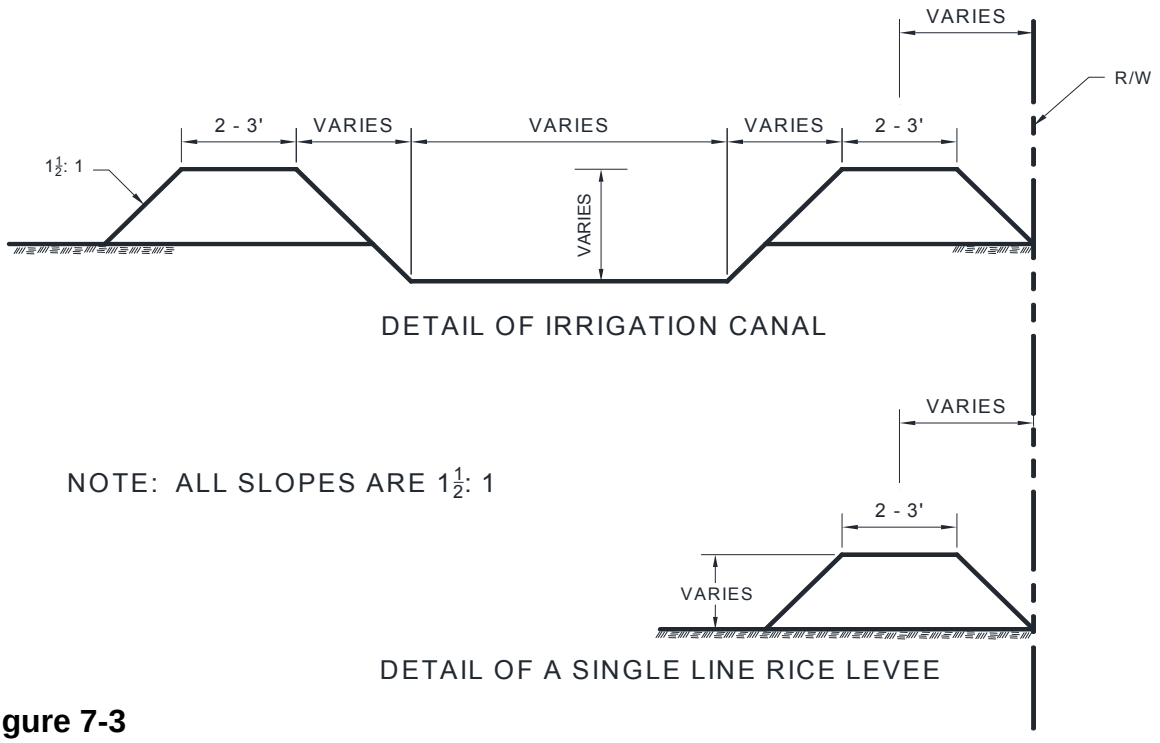


Figure 7-3

Refer to the dimensions shown in Figure 7-3, fill in the blanks with the correct answer.

a. The slopes for the sides of the canal and levee are _____.

b. Both the canal and levee are constructed outside of the _____.

c. Record the distance from the R/W line to the center of the rice levee_____.

d. Record the depth of the rice levee._____.

7-3. *(continued)*

e. Record the width at the top of the rice levee. _____

f. Will the width of the rice levee base vary if the height of the levee is increased? _____

g. The distance from the R/W line to the center of the **right** irrigation canal levee is _____.

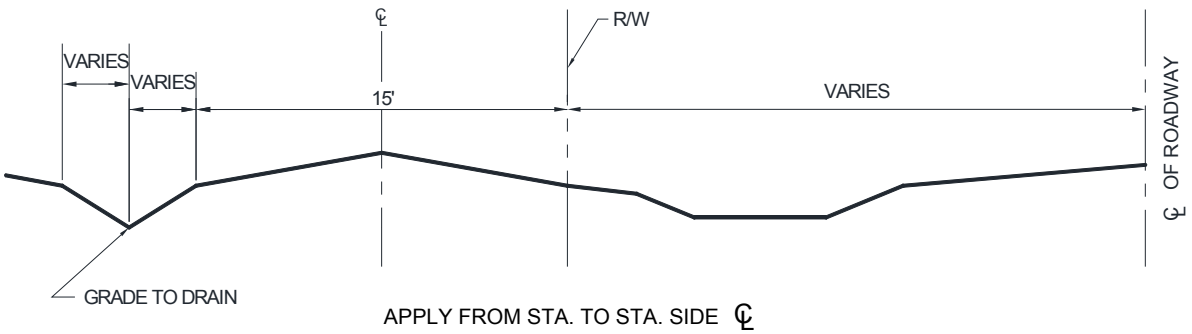
h. The horizontal width of the inside slopes of the irrigation canal is _____.

i. How wide are the tops of the irrigation canal levees? _____

j. Record the height of the irrigation canal_____.

HEADLANDS

7-4. A **Headland** is a place (area) to turn farm machinery around **outside of the R/W line**; it is constructed for the benefit of the property owners.



APPLY FROM STA. TO STA. SIDE ℄

129 + 16 - 131 + 13 LT
156 + 02 - 161 + 54 LT
161 + 86 - 166 + 60 LT
104 + 64 - 111 + 50 RT
151 + 52 - 162 + 58 RT

Figure 7-4: DETAIL OF A HEADLAND

7-4. *(continued)*

Figure 7- 4 (*previous page*) shows an example of a **Cross-Section Detail of a Headland**.

Listed below are the components that make up the Headland. Starting at the roadway centerline and moving to the left, they are:

- the left side of the subgrade.
- the left foreslope.
- the left ditch (bottom).
- the left backslope.
- the R/W line.
- the Headland.
- a drainage ditch.

Examine Figure 7- 4, then fill in the blanks with the correct answer.

a. How wide is the headland? _____

b. For whom are headlands constructed? _____

c. Headlands are constructed so farm machinery can be _____ outside of the R/W line.

7-5. Observe the Station numbers recorded under the Headland cross-section drawing in Figure 7-4. *(i.e. STA. 129 + 16 - STA. 131 + 13 LT)*

The Station numbers identify the position (*Station*) of the Headland, left or right of the roadway centerline. For example, consider the notation –

"**229 + 24 – 230 + 46 RT**"

This note indicates that the headland is constructed on the **RIGHT** side of the roadway centerline between **Station 229 + 24** and **Station 230 + 46**.

7-5. *(continued)*

Subtracting the lesser Station number from the larger Station number gives the **linear feet** associated with each portion of the Headland.

For example:

To calculate the distance,
subtract Station 229 + 24 from Station 230 + 46.

23046
- 22924
122 LF of headland

Consider the Headland cross-section in Figure 7-4, use the spaces below to answer the following questions.

a. Calculate the **total length** for all headlands on the **left** side of the roadway centerline.

b. Calculate the **total length** of headlands for the **right** side of the roadway centerline.

c. What is the **Station** number where the headland ends on the **left** side of the roadway centerline? _____

(hint: recall "line ahead" and "line behind" from chapter 2)

d. What is the **Station** number where the headland begins on the **right** side of the roadway centerline? _____

(hint: recall "line ahead" and "line behind" from chapter 2)

CHAPTER REVIEW QUESTIONS

a. A single line rice levee keeps the water in flooded fields from_____ into the _____.

b. An irrigation canal is used to carry _____.

c. Are the canals and levees discussed in this Section constructed inside or outside of the R/W line? _____

d. Why are headlands constructed? _____

e. Are headlands constructed inside or outside of the R/W lines?_____

f. Turnouts connect other _____ with the main highway.

g. Special Details contain the construction items that are _____ yet _____ to the individual project.

***Note**: Check your responses against answer sheets found at the end of this manual. If you missed MORE than three questions, review this chapter again and correct any wrong answers before progressing.*

TRAINING NOTES

CHAPTER 8
DRAINAGE MAP PLAN SHEETS

INTRODUCTION

Surface water drainage is of particular concern when building roads. Provisions in the plan set call for the construction of drainage structures, culverts, ditches, etc. to control the flow of water across the project. Water must drain in a way that will not cause soil erosion or damage to the earth during and after construction.

Prior to construction, the department surveys the area of proposed construction for existing drainage systems; this information is on **EXISTING DRAINAGE MAPS**. After which, the department prepares **DESIGN DRAINAGE MAPS** showing how to control surface water on and near the proposed project.

Also included in the plan set are Standard Plan Sheets and/or Special Details Sheets, which contain construction data for the drainage structures.

The index on Sheet 1 of the State Project H. 000238 (Drain Creek Bridges on U.S. 90) shows the absence of Existing and Design Drainage sheets. Therefore, this chapter will reference the Existing and Design Drainage sheets from State Project, 268-01-0012, I - 12 – DUMPLIN Creek.

Open the Highway Plan Book, locate the Title Sheet for the State Project I-12 – DUMPLIN Creek, and find the Index to Sheets. Note the Existing and Design Drainage sheets for this project are 40 - 55; several of which are included in the Highway Plan Book, review these sheets before progressing.

Throughout the chapter, consecutive **TOPIC** numbers indicate various facets of information pertaining to Existing and Design Drainage sheets. Occasionally, topic numbers will reference one another.

As in the previous chapter, review questions relating to the subject information appear periodically. Complete each question, as they will become useful study guide material.

SHEET FEATURES

8-1. Most project plan sets have two types of drainage maps, EXISTING DRAINAGE and DESIGN DRAINAGE.

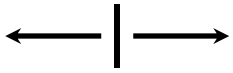
The scale on these drawings vary, with a range of 1″ = 100′ to 1″ = 1000′.

EXISTING DRAINAGE MAPS are part of the survey information for most projects. Their primary purpose is to indicate the size, shape, and direction of flow for all structures affecting drainage with regard to the proposed roadway. Included on the map are existing roadways, railways, and drainage structures found within the vicinity of the proposed project. An example of an **Existing** Drainage Map is Sheet 40 *(I-12 Dumplin Creek)* in the Highway Plan Book.

DESIGN DRAINAGE MAPS show basic drainage design data including **hydrologic** information and design criteria for cross-drain structures. For urban projects, it shows basic design data for the storm sewer system. An example of a **Design** Drainage Map is Sheet 43 *(I-12 Dumplin Creek)* in the Highway Plan Book.

Both Existing and Design Drainage maps show the centerline of the roadway along with **bold lines** that indicate drainage areas. **Small arrows** point in the direction of the natural drainage flow of surface water.

Vertical lines represent crests or hilltops. Arrows pointing in opposite directions next to vertical lines indicate that **surface water drainage** can flow in either direction (left or right.)



Fill in the blanks below with the correct answer.

a. Refer to Sheet 40 *(I-12 Dumplin Creek)*. At Station 120+00 **west** of the LA 447, the surface water flows from the _____

(chose one: ***N**orth to the **S**outh, **S**outh to the **N**orth, **E**ast to the **W**est, **W**est to the **E**ast*)

b. Bold lines delineate the _____ areas.

8-2. Recall these existing drainage structure symbols from Chapter 4. *(Figure: 8-1)*

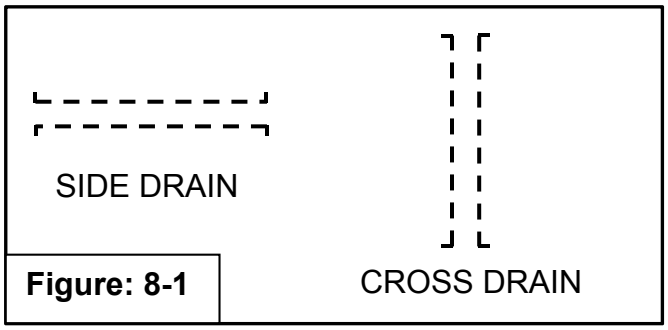


Figure: 8-1

Drainage construction requires the use of many different types of pipe. Below are common pipe abbreviations associated with drainage maps.

C.P.	Concrete Pipe
R.C.P.	Reinforced Concrete Pipe
C.M.P.	Corrugated Metal Pipe
S.D.	Side Drain

R.C.B.	Reinforced Concrete Box culvert
C.D.P.	Cross Drain Pipe
S.D.P.	Side Drain Pipe

Adding an "**A**" to any of the abbreviations above indicates the pipe is an "**arch**" design, e.g. **C.M.P.A.** = Corrugated Metal Pipe **Arch**

8-3. Open the Highway Plan Book to Sheet 40 *(I-12 Dumplin Creek)*. Notice the drainage structure information shown throughout the project. Information about existing **side drains** appear next to each location, while **cross drain** information appears in the **Cross Drain Information** table.

Find Station 112 + 19.45 in the middle of Sheet 40. The side drain located at this station is a concrete pipe 81′ long with a diameter of 18″ serving a drainage area (**DA**) of 7 acres.

Recorded near the pipe is the abbreviation, "**INV**" (**invert elevation**.) These numbers are the elevations at the north and south end of this pipe, and indicate the "***flow line***" (31.68′ and 31.60′ respectively.) In any drainage structure, the lowest line along which water can flow is called the Flow Line (FL) or Invert

8-3. *(continued)*

Locate the drainage structure on Sheet 40 at Station 112 + 16.43; it is on the east side of the highway. Fill in the blanks below with the correct information.

a. Record the size of structure _____

b. Record the structure type. _____

c. Record the Drainage Area acres. _____

d. Flow line ***(INV elevation)*** at the North end of pipe _____

8-4. Figure: 8-2 is a cross-section of a metal or concrete "**PIPE ARCH.**"

Note: A **PIPE ARCH Span** (**S**) is always larger than the **Rise** (**R**).

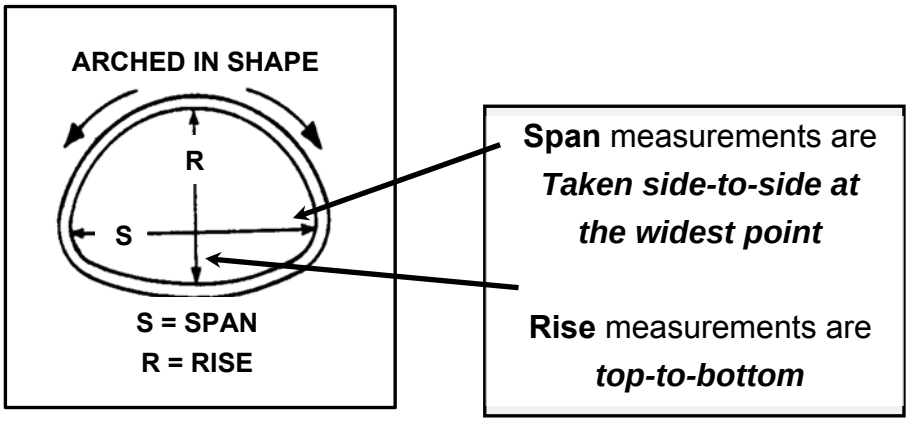


Figure: 8-2 PIPE ARCH

Locate Sheet 41 *(I-12 Dumplin Creek)* in the Highway Plan Book. Find the **Cross Drain Information** table. At Station 122 + 52 there is a 51′ long **CMPA,** with an 18″(R) and 36″(S). Answer the following questions about the Cross Drain at Station **122+47**.

a. The pipe is made of _____

b. The span is equal to _____ inches.

c. The rise is equal to _____ inches.

d. The pipe is _____ feet long.

8-4. *(continued)*

e. The shape of the pipe is a(n) _____.

f. The span of a **pipe arch** is measured from _____.

8-5. A **culvert** is any structure **not** classified as a bridge, providing an opening under the roadway. Culverts can be many shapes: round, square, arch, etc. *(Figure 8-3)*

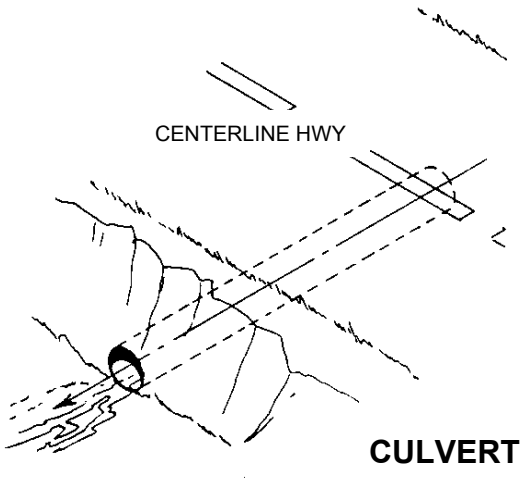


Figure: 8-3

8-6. Find Design Drainage Map Sheet 43 *(I-12 Dumplin Creek)* in the Highway Plan Book. Notice throughout the drawing that there are many existing drainage structures with notations. Also, notice the small arrows depicting the *surface-water flow-direction*.

In the lower right corner of Sheet 43 is the **Hydrologic Summary Table** showing the new cross-drain **Structure Number**, **Station Number**, **Size**, **Type**, **Drainage Area** (in acres,) **Allowable Headwater Elevations** and other information.

> ***Hydrology*** *is the study of the movement, distribution, and quality of water on Earth and other planets, including the hydrologic cycle, water resources, and environmental watershed sustainability.*

The **Allowable Headwater Elevation** is the highest elevation the surface water reaches during the rainy season.

Refer to Hydrologic Summary Table on Sheet 43 to answer the questions on the following page.

8-6. *(continued)*

a. How many acres of drainage area are listed for structure number 401?_____

b. What is the Allowable Headwater elevation? _____

c. The surface water feeding this cross-drain flows **from** the _____. (N,S,E,W)

8-7. Find the cross drain information table regarding existing pipes on Sheet 40 *(I-12 Dumplin Creek)* in the Highway Plan Book,

- The cross drain consists of three **concrete pipes (C.P.)** each with a diameter of 36″ and a length of 149′.
- Since only one size is shown, it is the **inside diameter (ID)**, and the pipe is round.
- When one dimension is given for a pipe specified as a "**pipe arch**," it refers to dimensions that are equivalent to a round pipe of that diameter.

Turn to Sheet 43 *(I-12 Dumplin Creek),* notice that the cross drain design at Station 122 + 45 allows for alternative types of pipe. This cross drain can be two pipes of either **30″ Reinforced Concrete Pipe Arch (RCPA) or 36″ Corrugated Metal Pipe Arch (CMPA)**.

Note: The Summary of Drainage Structures on Sheet 46 *(I-12 Dumplin Creek)* shows additional information about all the drainage structures on this project. Chapter 12 discusses *"The Summary of Drainage Structures"* in detail.

8-8. Open the Highway Plan Book to Sheet 45 *(I-12 Dumplin Creek)*. Refer to structure number **300** found in the **Hydrologic Summary Table**, fill in the blanks with the correct answer.

a. What is/are the recommended structure size(s) and type(s) for the cross drain at station 56 + 73?_____

b. Record the Headwater Elevation for this structure. _____

c. What is the 24-hour rainfall intensity for this culvert? _____

(hint: look under the table)

8-8. *(continued)*

d. Record the Tail-Water Elevation for this structure._____

e. The direction of flow for this the culvert is _____

(N to S), (S to N), (E to W), (W to E)

f. What is the drainage area for this culvert? _____.

g. From a previous topic: A culvert is a structure not classified as a _____ providing a(n) _____ under the _____.

NOTE:

Dimensions on drainage structures are always ***inside dimensions***.

This allows for accurate ***maximum flow rate*** calculations.

8-9. Open the Highway Plan Book to Sheet 207 *(H.000238 Drain Canal Bridges)*. Refer to the drawing in the upper left quadrant of the sheet. This sheet shows Typical **Temporary Erosion Control Details.** When building roads, it is important to minimize the impact on the environment. Erosion can damage roadways under construction, and result in unnecessary downstream water pollution. **Temporary Erosion Controls** are required for most road construction projects.

CHAPTER REVIEW QUESTIONS

a. Small arrows point in the direction of the _____ of surface water.

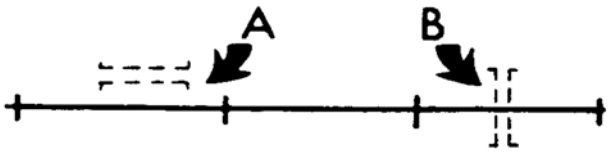
b. What is the drainage area for structure number 401 on Sheet 43 *(I-12 Dumplin Creek)*?_____

c. What is the direction of flow for this drainage area?_____

(N to S) (S to N) (E to W) (W to E)

CHAPTER REVIEW QUESTIONS *(continued)*

d. Which of the drain symbols accurately depicts a cross drain? (A or B)_____



Write the correct descriptions for the following acronyms/abbreviations in the blank.

e. R.C.B. _____

f. C.M.P.A . _____

g. D.A. _____

h. R.C.P. _____

i. INV. _____

j. C.M.P. _____

k. _____ _____ maps show basic drainage design data including design criteria for cross-drain structures.

l. _____ maps are part of the survey information for most projects.

m. The side-to-side measurement of a pipe arch is called _____.

n. Dimensions on drainage structures are _____ dimensions *(inside or outside.)*

o. When building roads, it is important to _____ the impact on the environment.

p. Allowable Headwater Elevation information is found in the _____ table.

***Note**: Check your responses against answer sheets found at the end of this manual. If you missed MORE than three questions, review this chapter again and correct any wrong answers before progressing.*

TRAINING NOTES

TRAINING NOTES

CHAPTER 9
SUBGRADE SOIL SURVEY SHEETS

INTRODUCTION

It is important that contractors know all they can about the ground (earth) prior to building the subgrade and subsequent roadway. Much is needed to know with regard to the **soil**. The "bullets" shown below are soil related questions that need answering prior to construction

- Is the soil compact or loose?
- Does the soil retain water, or permit it to drain away?
- Is the quality of the material (soil) suitable enough for the contractor to build a highway?

These questions and more are answered with the information gathered by the **Geotechnical Testing Engineer**.

Most of the time the **District Laboratory Engineer** decides the number of soil samples needed for the project. The District Laboratory Engineer also determines each sample location.

Ground borings are taken along the project, then **grouped** and **classified** according to **soil types**. These borings provide information to the Engineers, helping them make informed decisions as to the suitability of the soil for each construction process. A **Subgrade Soil Survey Sheet** containing this information is attached to the plan set.

As in the previous chapter, review questions relating to the subject information appear periodically. Complete each question, as they will become useful study guide material.

INTRODUCTION *(continued)*

Open the Highway Plan Book to Sheet 130 *(I-12 Dumplin Creek)*. This is an *example* of a **Subgrade Soil Survey Sheet**.

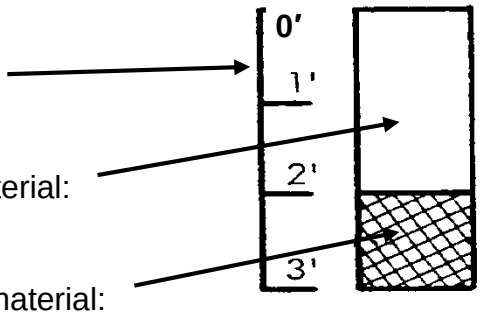
At the top of the sheet is a **LEGEND** explaining various symbols and abbreviations that appear throughout the sheet.

Below the ***LEGEND*** is the soil **SAMPLE LEGEND.** It shows the descriptions and classifications for the different types of soil taken from each boring site.

SOIL SURVEY SYMBOLS

9-1. This is an example of a **Boring Symbol.** Beside it are explanations with leader lines pointing to the symbol describing the various components.

- A **scale** indicates the depth of the boring:
- This **legend symbol** indicates suitable material:
- This **legend symbol** indicates unsuitable material:



Refer to Subgrade Soil Survey Sheet 130 in the Highway Plan Book. Notice the **boring symbols** located on the left half of the sheet. A **scale** under each row of symbols indicates the Station number location of each boring. An "**EB**" or "**WB**" follows each Station number. For this project, the top row of borings corresponds to the eastbound lanes (**EB,**) and the bottom row corresponds to the westbound lanes (**WB**.)

Another symbol found on the boring symbols is a ***number in a circle*** (i.e. ⑤). Each circled number corresponds to the Sample Legend, which in turn describes the **soil type** found in the boring.

9-1. *(continued)*

Use the boring symbol located at Station 680 + 00 EB to answer the following questions.

a. What is the depth of the boring? _____

b. How many feet of *suitable* material are in the boring? _____

c. How many feet of *unsuitable* material are in the boring? _____

d. Write the number(s) for the **suitable** soil type(s.) _____

e. Write the number(s) for the **unsuitable** soil type(s.) _____

Continue to refer to the boring symbol located at Station 680 + 00 EB to answer the following questions, fill in the blanks with the correct answer.

f. The symbols and abbreviations used throughout the Subgrade Soil Survey Sheet are explained in the _____

g. The description and classification of the soil types found in the borings are listed in the _____ _____. (*hint: two words*)

h. A _____ shows the depth of each boring site.

i. Refer to the **LEGEND** and **SAMPLE LEGEND** on Sheet 130 *(I-12 Dumplin Creek)*; write the definitions for the following acronyms/abbreviations.

S.S.L._____

P.I. _____

H.M._____

9-2. This is an example of an A-group soil classification number:

A-4

Soils are divided into 8 major groups, A-1 through A-8.

- Lower A-group numbers, A-1, A-2, A-3, and A-4, **are favorable** when building roads. They are soils containing "aggregate" materials, such as gravel, stone, shell, and sand.
- A-6 and A-7 soils have the most clay content.
- Soil group A-8 contains organic material, which is **not suitable** for highway construction.
- Group A-5 soils are not common to Louisiana.

Many times notes appear on Subgrade Soil Sheets indicating **select** (favorable) material Group numbers, such as the note "A-6 or better…" listed in the Legend on Sheet 130.

Liquid limit (LL), **plasticity index (PI),** and **group index** are numbers describing the physical characteristics of soil.

- The liquid limit and plasticity index identify the water content of the soil
- Group index numbers relate to the size of soil particles. These index numbers are included with the subgrade soil group, and are usually found written in parenthesis next to the Soil Group number.
  (Soils with an LL of 35 or less, and a PI of 20 or less, are also listed as part of the note on Sheet 130 indicating select material.)

Answer the following questions; write the correct answer in the blank.

a. The _____ contains the description of soils on a Subgrade Soil Survey Sheet.

b. Which soil groups are most preferred when building a road? (<u>lower</u> A-group numbers or <u>higher</u> A-group numbers) _____

9-2. *(continued)*

In many cases, the original material (soil) found along the centerline of a proposed highway project is not suitable for the construction of the subgrade. After removing this material, specific materials are brought in to take its place. Subgrade Soil Survey Sheets determine the location of suitable materials.

Refer again to Subgrade Soil Survey Sheet 130 *(I-12 Dumplin Creek)*; locate the two rows of borings.

On the left side of the page, a **scale** indicates the **depth of the borings**. Another scale below each row of borings shows the respective Station numbers.

Look at the notation located in the lower left corner of Subgrade Soil Survey Sheet 130; it indicates, "*all borings were taken along the shoulders of the roadway*."

9-3. Numbers within in a circle show the **location** and **identity of each soil sample** tested in the laboratory. For example, ② appears in two places on the Subgrade Soil Survey Sheet.

- at the top of the boring symbol at Station 680 + 00 EB
- and in the Sample Legend

Answer the next two questions with regard to soil sample ⑥ :

a. What is the boring location (Station) of this sample? _____

b. What is the Soil Group number? _____

9-3. *(continued)*

Refer to the Subgrade Soil Survey Sheet 130 *(I-12 Dumplin Creek).* Do the borings at the following Station numbers contain **unsuitable** or **non-select** materials? (*write Yes or No*)

c. Station 703 + 00 WB _____

d. Station 767 + 00 WB _____

e. Station 787 + 00 EB _____

SOIL CHARACTERISTICS

9-4. The **Sample Legend** on Subgrade Soil Survey Sheet 130 describes the physical attributes of each soil type found in the borings.

Find sample ②; notice it is described as **SOFT BRN. SILTY LOAM** . This is the "Verbal Description" for this soil type (*soft brown silty loam.*)

Found under the description, are additional numbers that require referencing the **LEGEND** portion of the sheet.

Find the following abbreviations under the **LEGEND** on Subgrade Soil Survey Sheet 130 *(I-12 Dumplin Creek)*.

- A-2-4(0)
- L.L.
- P.I.
- N.P.
- (0,0,23,48,10,10)

9-4. *(continued)*

Below are the interpretations for each:

A-2-4(0)	=	subgrade soil group and group index
L.L.	=	Liquid Limit
P.I.	=	Plasticity Index
N.P.	=	Non-Plastic
(0,0,23,48,10,10)	=	% retained on sieves #4, #10, #40, & #200 along with the % silt & % clay

Look back at the **Sample Legend** and find ② , the second line is as follows:

A-4(0) N.P. (0,0,6,56,28,10)

② is **soft brown silty loam**

- subgrade soil group A-4
- group index “0”
- non-plastic
- with 0% retained on sieves #4 and #10
- 6% retained on sieve #40
- and 56% retained on sieve #200.

② is 28% silt and 10% clay.

Use Subgrade Soil Survey Sheet 130 *(I-12 Dumplin Creek)* to **fill in the blanks** with the correct information concerning Soil Sample ③.

a. Verbal description:_____

b. Subgrade soil group and group index: _____

c. Liquid limit: _____

d. Plasticity index: _____

9-4. *(continued)*

e. Percent retained on # 4, #10, #40 and #200 sieves _____

f. Percent silt: _____

g. Is the material suitable for road construction? _____

h. What is the Station number of the boring for Sample ③?_____

9-5. Refer to Station **46 + 00 WB** on Subgrade Soil Survey Sheet 130 *(I-12 Dumplin Creek)*; **fill in the blanks** with the correct answers using the data regarding the boring.

a. Approximate how many feet of suitable material were found. _____

b. How many feet of unsuitable material were found? _____

c. How many soil types were found in the boring? _____

Fill in the blanks below with descriptions of **<u>unsuitable</u>** or **<u>non-select</u>** material:

d. Appearance _____

e. Soil group and group index _____

f. Liquid limit _____

g. Plasticity index _____

9-6. Refer to the boring at Station 720 + 00 EB on Subgrade Soil Survey Sheet 130.

Fill in the blanks with the correct answers using the data regarding the boring.

a. Approximate depth of this boring. _____

b. Does the boring contain non-select or unsuitable material?_____

Describe the **<u>suitable</u>** material:

c. Appearance _____

d. Soil group and group index _____

e. Plastic or non-plastic _____

9-7. The depth of the boring at **Station 730 + 00 EB** is greater than the allowance on the scale. Notice the information about the boring has changed positions, and is now located to the right of the top row of borings; it is referenced with an asterisk. What is depth of this boring? _____

CHAPTER REVIEW QUESTIONS

9-8. Answer the following questions about the boring taken at Station **790 + 00 WB** on Sheet 130 *(I-12 Dumplin Creek)*. Record answers to the nearest 0.5 foot

a. How many feet of suitable material were found? _____

b. How many feet of unsuitable material were found? _____

c. How many types of unsuitable material were found? _____

Describe the suitable material:

d. Appearance: _____

e. Soil group and group index: _____

f. Plastic or non-plastic: _____

9-9. Use the blank space in the table to **record the definitions** for each abbreviation or symbol.

a.	P.I.	
b.	L.L.	
c.	N.P.	
d.	A-3	
e.	②	
f.	S.L.	
g.		
h.		

9-10. Soils must contain certain attributes to make them **suitable for use** in highway construction. **Place a check** in the appropriate box to indicate if the listed attribute needs to be a high or low number.

	High Number	Low Number
a. Soil group	☐	☐
b. Liquid limit	☐	☐
c. Plasticity index	☐	☐
d. Group index	☐	☐

9-11. Soil group A-8 contains _____ _____. (*hint: two words*)

9-12. Most of the time the _____ _____ _____ decides on the number soil samples needed for the project. (*hint: three words*)

***Note**: Check your responses against answer sheets found at the end of this manual. If you missed MORE than three questions, review this chapter again and correct any wrong answers before progressing.*

TRAINING NOTES

CHAPTER 10
STANDARD PLAN SHEETS

INTRODUCTION

In order for the construction of Louisiana roads to be as nearly alike as possible, the department uses **Standard** plans. Standard plans are included in almost every plan set. They show the repetitive construction details of structures, fences, highway signs etc. Since Standard Plans show *standard* features of construction, it is possible to define *standard* methods of construction inspection. As a result, the department can manage consistent construction standards and quality. Standard plans also allow contractors to improve their bid accuracy by comparing costs from past construction projects.

Open the Highway Plan Book to sheets 260 and 261 from State Project H. 008244, Plaquemines. These two sheets are examples of Standard Plans depicting construction and placement of Right-Of-Way Markers. All roads, from secondary to interstate, use Right-Of-Way Markers. It is important for Right-Of-Way Markers to look alike, and be placed in specific locations.

Many Standard Plans exist, and this chapter will review several of them starting with Standard Plan sheets containing Culvert (drainage) design information.

BOX CULVERTS

10-1. A **Culvert** is an opening or series of openings designed to carry water under the roadway. Although the terms culvert and bridge are sometimes used interchangeably, they are different structures. Culverts can be any drainage structure under a roadway or other facility not defined as a bridge.

(Section 101.03, 2006 LADOTD Standard Specifications for Roads and Bridges)

Figure 10-1 shows the main components of a culvert with plan view drawings.

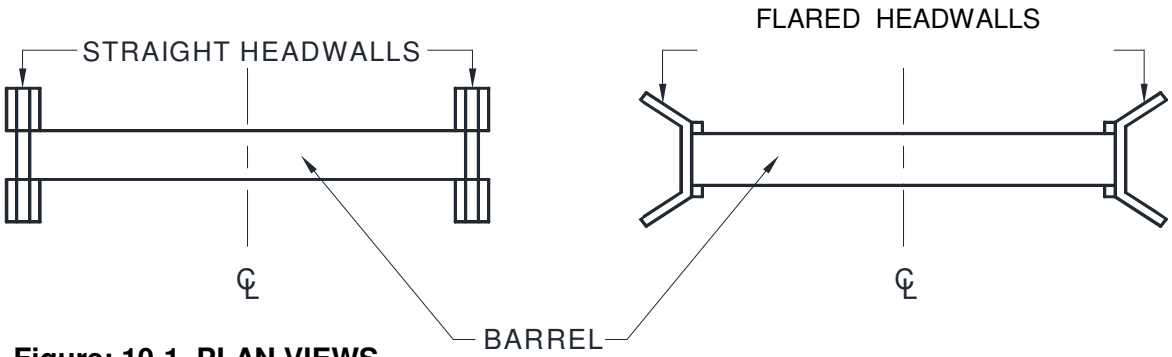


Figure: 10-1 PLAN VIEWS

10-1. *(continued)*

Notice that **Headwalls** form the end of the culvert, and **barrels** extend under the roadway.

The example on the left in *Figure 10-1* shows **straight headwalls**, while the drawing on the right shows **flared headwalls**. Headwalls can also take the shape of an "**L**" or "**U**."

10-2. Culvert construction takes place one section at a time. It is important to know the culvert components prior to reviewing any detailed dimensions, diagrams, or construction materials.

Figure 10-2 is a cross section of a **barrel;** it has four components, the **bottom slab**, **two walls,** and a **top slab**. Also, observe the chamfers and keyed construction joints.

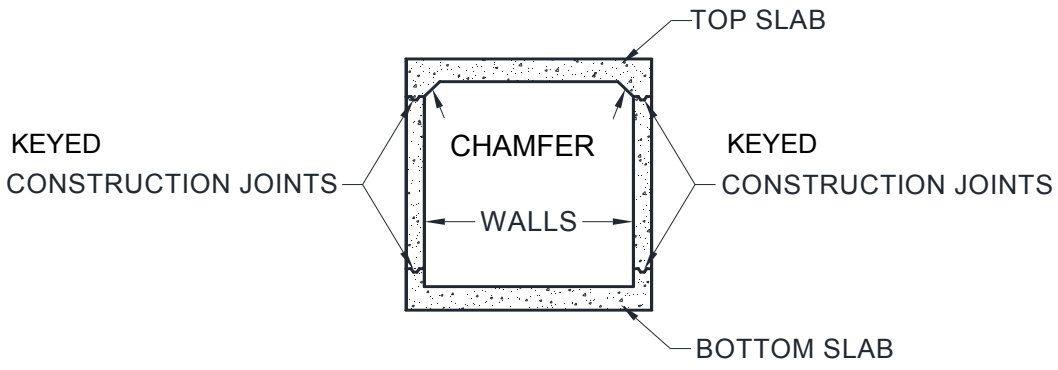


Figure: 10-2. CROSS SECTION OF BARREL

10-2. *(continued)*

Notice the shape of the concrete construction joints from *Figure 10-2*. They are "Keyed Joints," designed to fit together without dislodging.

Figure 10-2a is an example of a typical Keyed Construction Joint used to join two pieces of concrete with a ¼″ of expansion material.

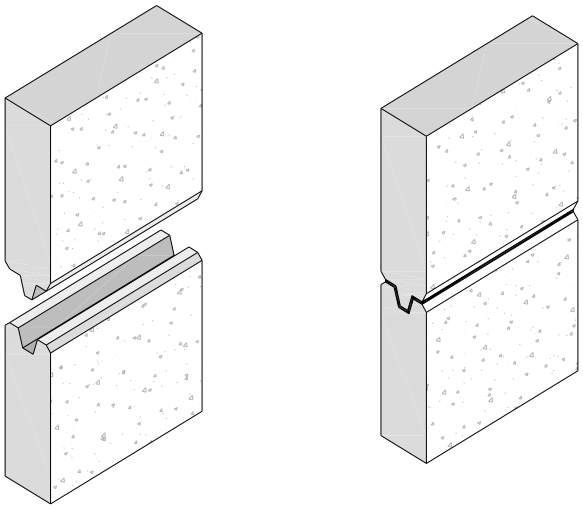


Figure 10-2a. Keyed Construction Joint with a ¼″ of expansion material.

10-3. **Box culverts** are aptly named for their box shape. Below, **Figure 10-3** shows an end view drawing of a **two-barrel** or **two-opening box culvert** without the headwall. An end view drawing of a "**pipe**" culvert would have a circular shape.

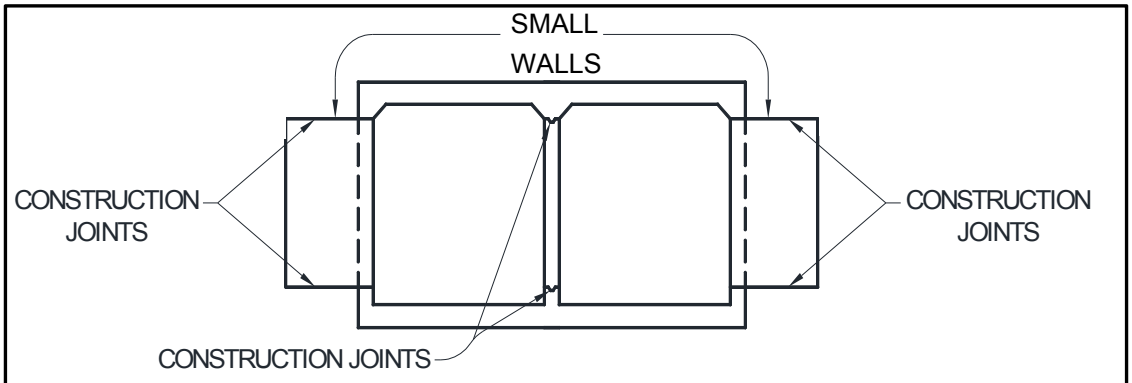


Figure: 10-3. Front view of a TWO - OPENING BOX CULVERT

The box culvert in Figure 10-3 also shows small walls protruding from each sidewall. Construction joints on these walls accept the components that make up the headwall. These smaller walls should not be mistaken for the headwall "wing walls," which will be discussed later in Topic 10-5.

10-3. *(continued)*

Figure 10-3a is an example of a two-barrel box culvert complete with headwalls.

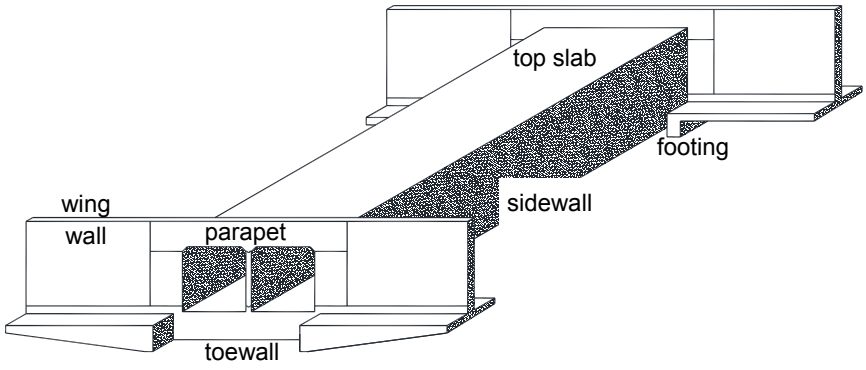


Figure: 10-3a. TWO-OPENING BOX CULVERT with Headwalls

10-4. Construction of the **headwall** consists of several parts: the toewall, a parapet, a footing, and two wing-walls. At the end of the two-barrel box culvert (***Figure 10-4***), the illustration shows the "**toewall**". A toewall is a concrete **footing** "poured" in place, to support the "wing-wall" portion of the headwall. Since each component of the headwall is constructed separately, they are connected with keyed construction joints, similar to the illustration in *Figure 10-2a*.

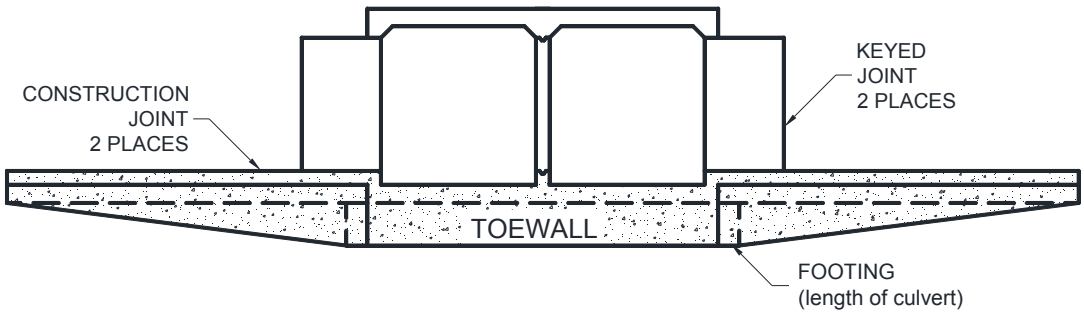


Figure: 10-4 TOEWALL and FOOTING

10-5. **Figure 10-5** is a drawing of the culvert with the **wing-wall** components of the headwall added. Wing-walls attach to the culvert sidewall by means of a keyed construction joint.

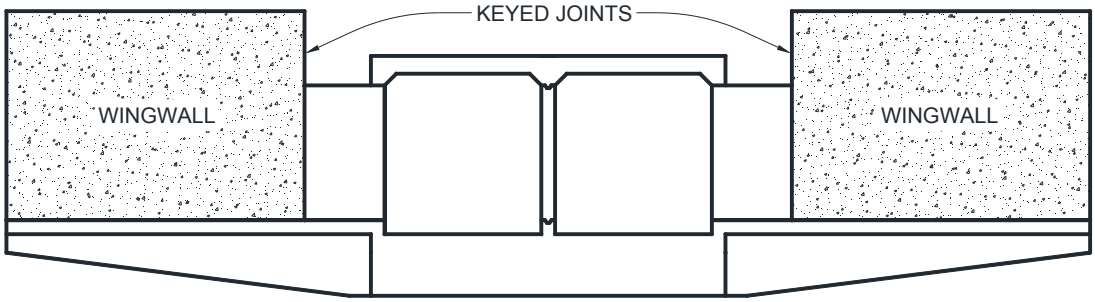


Figure: 10-5. WINGWALL

10-6. Completing the headwall construction is the **parapet** *(Figure 10-6.)*

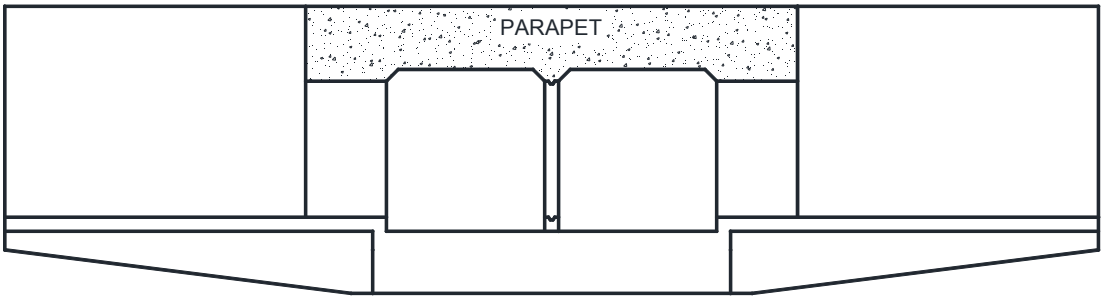


Figure: 10-6 PARAPET

List two of the four components that make up a box culvert.

a. _____

b. _____

10-6. *(continued)*

List the three of the four components that make up the headwall.

c. _____

d. _____

e. _____

10-7. It is now common to find sections of precast concrete culverts that are manufactured then shipped to the construction site where they are assembled. However, concrete culverts may also be job site constructed in four separate concrete “pours” (four stages).

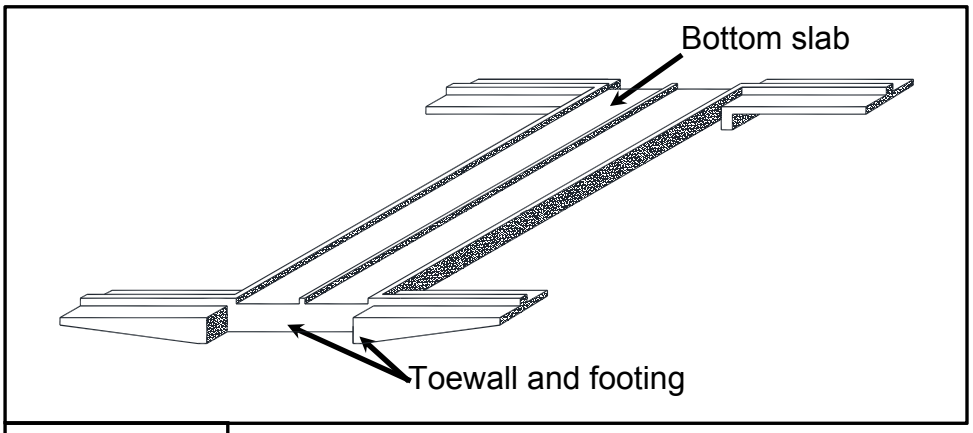


Figure 10-7

Figure 10-7 shows the toewall, footing, and bottom slab as the first culvert components to have forms built and concrete *poured* during the construction of a “poured in place” culvert.

10-8. ***Figure 10-8*** shows the barrel sidewalls; the *second* component to have forms built and concrete *poured* during the construction of a “poured in place” culvert.

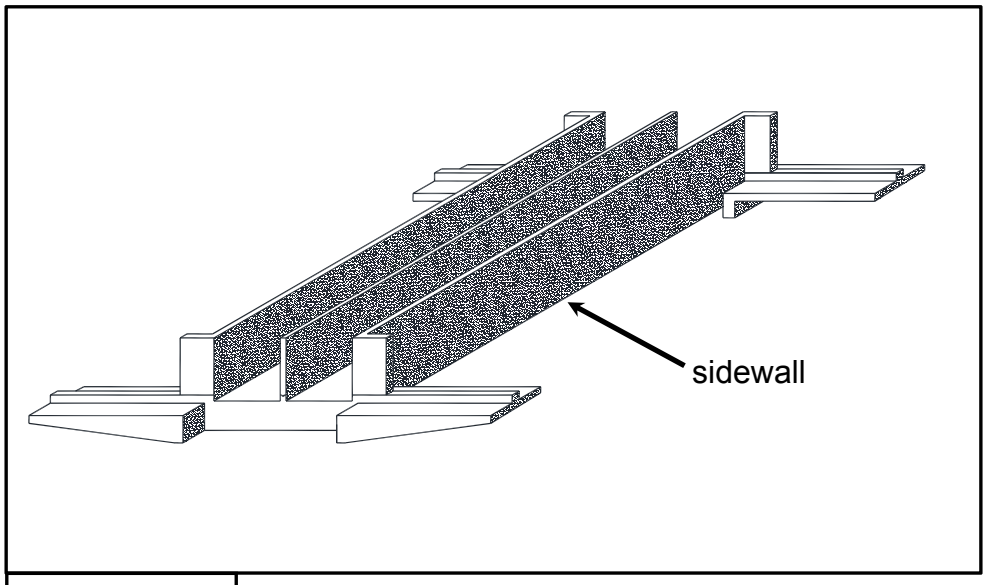


Figure: 10-8

10-9. The top slab and the parapet *(**Figure 10-9**)* are the culvert components *poured* during the third phase of “poured in place” culvert construction.

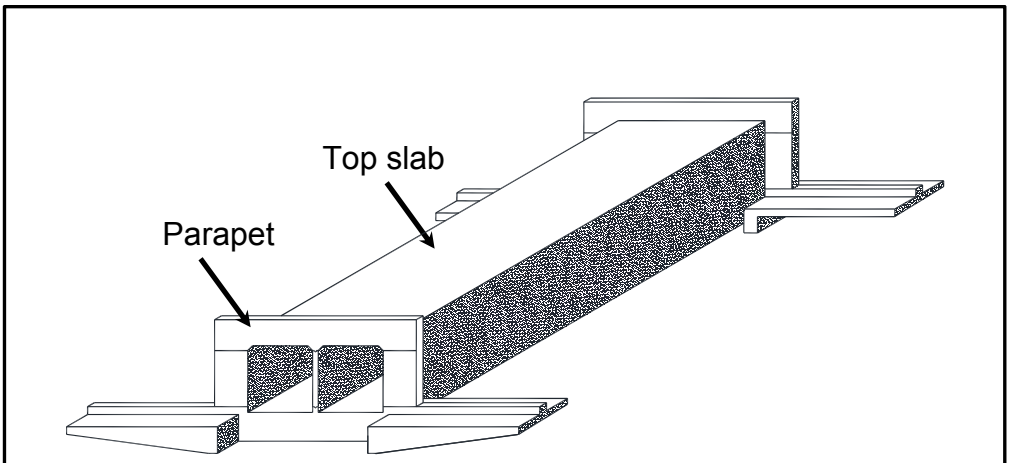


Figure: 10-9

10-10. Completing the concrete *pouring* process for culvert construction is the "wing-walls" *(**Figure 10-10**.)* Wing-walls sit on top of the toewall footing.

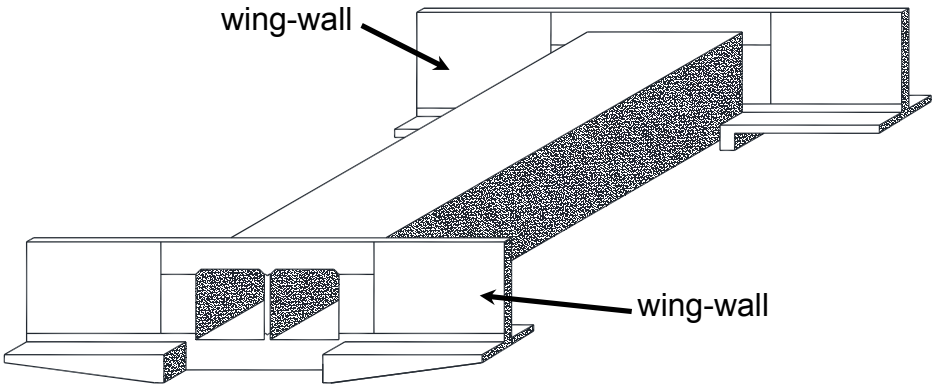


Figure 10-10

Fill in the blanks with the correct answer.

a. What portion of the headwall is poured at the same time as the bottom slab of the barrel? _____

b. Record the culvert component constructed during the second pour.

_____

c. What part of the headwall is constructed at the same time as the top slab of the barrel? _____

10-11. Refer to Sheet 205 *(State Project H. 008244, Plaquemines)* in the Highway Plan Book. This is Standard Plan CCSM4-6 S 90° 1.

Now find Sheet 303 *(I-12, Dumplin Creek)* in the Highway Plan Book. This is Standard Plan CCSM6-7 R 60° 1. Compare the two standard plans. Notice that the multiple barrel box-culverts on Sheet 303 are at a 60° angle to the roadway, while Sheet 205 shows multiple barrel box-culverts at right angles to the roadway.

Look at both Standard Plan sheets, and locate the following items; after finding each, place a check in the box.

- ☐ the Plan View
- ☐ this symbol 

  It is at the top of the barrel in the Plan View, and the right side of Section A-A. This symbol is a *break line*, and in this case, it is indicating a partial section. Information within the portion drawn on the page is repeated throughout the missing portion of the section *(repetitious information is not shown, yet it is implied.)*
- ☐ Section symbols A-A and B-B (in Plan View)
- ☐ Section drawings A-A and B-B (top right of sheet)
- ☐ the End Elevation
- ☐ the Section thru Barrel

10-12. Review the two section drawings on Sheet 205 *(State Project H. 008244, Plaquemines)*. Note how each illustrates the different parts of the culvert.

Section A-A is a longitudinal section showing the inside construction of the barrel, parapet and toewall.

Section B-B is a section of the wing-wall revealing the construction details from an inside perspective. Notice the construction joint near the bottom of the wing-wall.

10-13. Other items of importance appear on Sheet 205 *(State Project H. 008244, Plaquemines)* in the Highway Plan Book. They are:

- **End Elevation -** showing the culvert, headwalls, and barrels as they appear from the *end*. The left half is a cutaway showing reinforcing steel (rebar) and construction joint placement.
- A barrel cross-section titled **Section thru Barrel** –revealing the inside construction of the barrel at a point behind the headwall.
- **Dimensions and Material Quantities** table
- **Bill of Reinforcing Steel for 44′-0″ Culvert** table

10-14. Refer again to Sheet 205 *(State Project H. 008244, Plaquemines)* in the Highway Plan Book. Locate the ***Section thru Barrel*** cross-section at the top of the sheet. Notice both the span and height are inside dimensions of the barrel, and share the word "Opening" as the dimension. Pertinent information needed to construct culverts of various sizes can be found in the **DIMENSIONS AND MATERIAL QUANTITIES** table.

The first three columns of the **Dimensions and Material Quantities** table give information about the "**openings**." For example, in the *first column **find** the numbers* **5 x 5**.

- 5 x 5 indicates the **span is 5 feet**, and the **height** of the opening is **5 feet**.
- The **second column** in the Dimensions and Material Quantities table indicates the appropriate row to read across for information on culverts with 2, 3, 4, 5, or 6 barrels (openings.)
- **Column 3** indicates the total area of the each opening in terms of square feet. For instance, a 3 barrel - 5′x5′ culvert equals 3 x (5x5) or 75 SF.

10-14. *(continued)*

Because culverts and their components are usually buried and surrounded with earthen (fill) material, the fourth and fifth columns of the *Dimensions and Material Quantities* table indicate the maximum amount of fill material allowed *(cubic yards)* relative to the culvert size.

- **column 4** shows the maximum allowable *(amount of)* fill allowed above the barrel top slab,
- **column 5** indicates the maximum allowable *(amount of)* fill above the wall.

The column headings for the next two columns in the *Dimensions and Material Quantities* table show letters. These letters refer to features located on the cross section titled ***Section Thru Barrel***. Below are the descriptions for the letters **T, A** and **Y**.

T = the thickness of the top slab and bottom slab.

A = the distance for each side of the barrel′s corner chamfers (recall Figure 10:2)

Y = the distance the **rebar** *(reinforcing steel imbedded in concrete)* is placed from the edges of the concrete

Dimensions for T, A and Y vary depending on the size of the barrel opening *(i.e. 4'x4', 5'x5', or 6'x6'.)*

Refer to the **Section Thru Barrel**, and the **Dimensions and Material Quantities** table on Sheet 205 *(State Project H. 008244, Plaquemines)*; fill in the blanks below with the correct information with regard to a ***5'x5' culvert***.

a. Thickness of top slab: _____

b. Thickness of bottom slab: _____

c. Thickness of walls: _____

d. Barrel corner chamfer distance _____

10-14. *(continued)*

e. Distance the rebar is placed from the edges of the concrete_____

f. Inside height dimension for a barrel: _____

10-15. Continue to review the *Dimensions and Material Quantities* table on Sheet 205. Notice that more letters appear as column headings below the words **Wings and Curbs**. These letters correspond to dimensions located in one of three places on sheet 205: the Plan drawing, the End Elevation drawing or Section B-B.

Locate the **PLAN** drawing on Sheet 205 *(State Project H. 008244, Plaquemines).* Read the dimension description below and observe the letters representing the dimensions on the right side of the drawing. Place a checkmark in the box as you find each dimension "letter;" then f**ill in the blanks with the correct measurement** from the *Dimensions and Material Quantities* table using the letters associated with a ***5'x5' culvert*** opening.

☐ **a)** Distance from the front edge of the wing-wall to the **outside** edge of the footing = **E**. _____

☐ **b)** Distance from the front edge of the wing-wall to the **inside** edge of the footing = **8″ + J** _____

☐ **c)** Overall width of the footing = **G**. _____

10-16. Locate the **END ELEVATION** drawing on Sheet 205. Read the dimension description below and observe the letters representing the dimensions. Place a checkmark in the box as you find each dimension "letter;" **then fill in the blanks with the correct measurement** from the *Dimensions and Material Quantities* table using the letters associated with a 2 Barrel - ***5'x5' culvert***.

☐ **a)** Distance from the top of the footing to the top of the wing wall = **H** _____.

10-16. *(continued)*

□ **b**) Overall length of the headwall = **M**. _____

□ **c**) Length of the wing wall = **P**. _____

□ **d**) Distance from the edge of the wing wall to the inside edge of the barrel = **L**. _____

10-17. The **Quantities** portion of the *Dimensions and Material Quantities* table on Sheet 205 *(State Project H. 008244, Plaquemines)* gives the quantities of steel (rebar) and concrete needed for each culvert size. Steel quantities are shown in pounds (LBS.), and concrete quantities are shown in cubic yards (CU. YDS.).

NOTE: The first two Steel and Concrete columns are *per linear foot of barrel length*, and the middle two columns are for an *entire* 44′-0″ culvert including the two headwalls.

Consider a culvert with four openings, each of which measures 4′x4′. Fill in the blanks **provided with the appropriate information by referring to the Steel and Concrete** columns located on the ***Dimensions and Material Quantities* table**.

a. How many pounds of steel are required for the **entire** 44′ culvert?

_____

b. How many pounds of steel are required **per linear foot** of barrel?

_____

c. How many cubic yards of concrete are required for the **entire** 44′ culvert?

_____

d. How many cubic yards of concrete are required **per linear foot** of barrel?

_____

10-18. Prior to pouring concrete, steel reinforcing bars *(rebar)* are assembled and placed within the concrete forms. Steel reinforces concrete as well as giving it tensile strength. The drawings on Sheet 205 also indicate the locations, placement, and diameter (Ø) of steel bars (rebar) within the culvert.

10-18. *(continued)*

This is the symbol used on views and elevations to depict the **end** of a piece of rebar.

●

This symbol is used on views and elevations to depict the **length** of a piece of rebar.

——— ——— ———

10-19. **Five** different forms (shapes) of steel rebar appear in the S*ection thru Barrel* drawing on Sheet 205 *(State Project H. 008244, Plaquemines)*.

1) Look at the top slab, notice that leader-lines point to "•" and indicate "**#4 Bars C,**" these pieces of rebar run the length of the top slab. Spacing between the bars is usually 12 inches from the center of one bar to the center of the next bar, but will be specified in the plans, if other spacing is used.

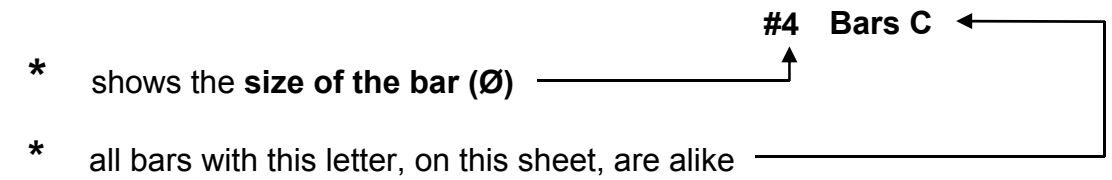
2) Locate **Bars A_1**, they look like this —— —— ——— and are placed in the top and bottom slab, above and below the inside barrel walls.

3 & 4) *Additionally,* **Bars A** and **Bars B** run the distance of the barrel span and have similar shapes to the drawings below.

5) Find **Bars D,** notice that they start in the top slab and run parallel through the barrel's sidewalls into the bottom slab.

Study the drawings on Sheet 205, *(State Project H. 008244, Plaquemines)* look for the same bars in other views; note their location and spacing before going on to the next topic.

10-20. INTERPRETING THE REBAR NOTATIONS



Reinforcing steel (rebar) is sized by the 1/8″. For example, a #6 rebar is 6/8″ in diameter, however, always reduce fractions to the lowest common denominator, in the case of a #6 rebar, the Ø = 3/4 inch.

- A number 3 (#3) rebar has a 3/8 inch Ø
- A number 4 (#4) rebar has a 1/2 inch Ø
- A number 5 (#5) rebar has a 5/8 inch Ø

10-21. Notice the **Bill of Reinforcing Steel for 44′- 0″ Culvert** table located in the lower left corner of Sheet 205 *(State Project H. 008244, Plaquemines)*. It contains rebar quantities, sizes, and lengths for each type of culvert opening.

For example, consider a **culvert with two openings**, each **4′x4′**, and we need information about **Bars A**. The table reads:

- The size of the steel is **#5**.
- The number of required bars is **92**.
- The length of each bar is **10′-0″**
- The spacing between each bar is **12″** from the center of one bar to the next *(OC = on center)* as shown in ***Figure 10-11***.

10-21. ***(continued)***

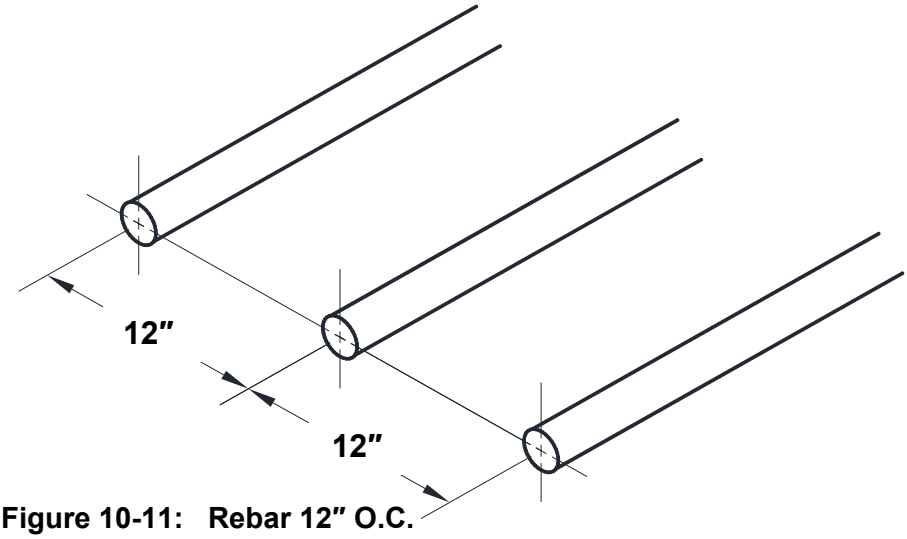


Figure 10-11: Rebar 12″ O.C.

Use the **Bill of Reinforcing Steel For 44′- 0″ Culvert** from Sheet 205 *(State Project H. 008244, Plaquemines)* to find the following information on **#4 Bars D** for a **five-opening**, **6′x6′** culvert.

a. Steel size _____

b. Number of required bars _____

c. Length of each bar _____

d. Spacing between bars _____

10-22. Some of the bars reinforcing this culvert have special shapes. Detail drawings show how they are shaped. In the lower right corner of Sheet 205 is a **special detail for Bars A** *(Figure: 10-12)*.

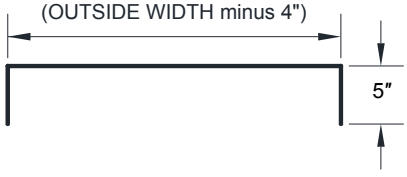


Figure 10-12: BARS A

10-22. *(continued)*

BARS A are placed in the top and bottom slabs of the culvert. Compare the special detail of *Bars A* with the *Bars A* shown in the *Section thru Barrel*. Notice that the horizontal dimension of the bar is the outside width of the culvert ***minus*** four inches. Measurements on the drawing usually show the distance the "5-inch hook" needs to be from the inside of the barrel walls *(approximately 2 inches.)*

Review the drawings on **Sheet 205**. Fill in the blank provided with the correct answer.

a. What part(s) of the headwall are reinforced by **Bars N**?_____

b. What part(s) of the headwall are reinforced by **Bars F**?_____

c. What part(s) of the headwall are reinforced by **Bars F_1**?_____

d. What part(s) of the headwall are reinforced by **Bars E**?_____

10-23. Consider a 6′x6′ - 3 opening culvert. Use the tables from Sheet 205 to fill in the spaces below with the correct reinforcing steel information.

		Size	No.	Length	Spacing
a.	**Bars A**				
b.	**Bars A_1**				
c.	**Bars B**				
d.	**Bars D**				

10-24. Reinforcing steel passes through Construction Joints, which in turn strengthens the joint. Review the drawings, drawing notations and information tables on Sheet 205 *(State Project H. 008244, Plaquemines)*. Then, determine the characteristics of each rebar; record that information in the following table.

	Joints between the:	Bar letter	Size (#)
a.	top slab and barrel walls *(hint: look at Section Thru Barrel)*		
b.	barrel walls and bottom slab *(hint: look at Section Thru Barrel)*		
c.	toewalls and wing-walls *(hint: look at Section B-B)*		
d.	wing-walls and the small wings extending from the barrel side walls *(hint: Keyed Jt. - left side of End & Plan)*		
e.	wing-walls and parapet *(hint: Keyed Jt. - left side of End Elev)*		
f.	toewall and the small wings extending from the barrel side walls *(hint: left side of End Elev)*		
g.	parapet and barrel top slab *(hint: left side of End Elevation)*		

10-25. Look at the **Bill of Reinforcing Steel for 44′-0″ Culvert** table on Sheet 205. Answer the following questions. Write the correct answer in the blank provided.

a. How many **Bars M** are required for each culvert? _____

b. Where are the **"M" Bars** located on the drawings? _____

(hint: look at the top of the End Elev)

10-26. Review the End Elevation drawing on Sheet 205 *(State Project H. 008244, Plaquemines)*. Find the following notation (a magnifying glass may help).

3″ Ø Weep-Hole

This is a three-inch diameter (Ø), round, weep-hole. Water seeps into the fill material behind the wing-wall and builds up pressure; the weep-hole allows this water to drain out of the fill, relieving the pressure.

a. List two places on Sheet 205 where the weep-hole notation is found.

_____

10-27. Notice the 6″ thick barrel walls in the SECTION THRU BARREL on Sheet 205 *(State Project H. 008244, Plaquemines.)* In order to construct the joints connecting the top and bottom slabs to the barrel walls, the GENERAL NOTES on Sheet 205 reference another Standard Plan, C.M.- 49 *("For Detail of Joints, See Std. Plan C.M.- 49.")*

Find Standard Plan CM-49, it is Sheet 211 *(State Project H. 008244, Plaquemines)* in the Highway Plan Book.

Detail "C" in the lower right corner of sheet 211 shows the dimensions and construction details for Keyed Construction Joints. The dimensions on this drawing correspond to the table located next to it.

10-28. **Figure 10-13**, similar to the drawing “Section C” located on sheet 211, shows a construction joint and the dimensions (taken from the table) for a 6″ thick barrel wall. Adding the dimensions together gives the thickness of the barrel wall or slab.

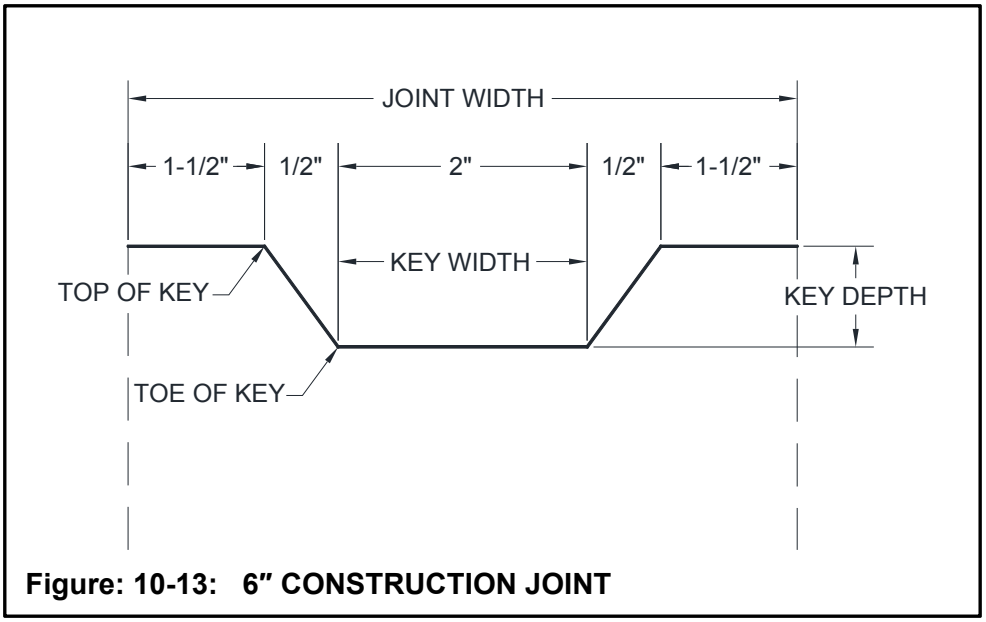


Figure: 10-13: 6″ CONSTRUCTION JOINT

10-29. Some joints in the culvert are **EXPANSION JOINTS**. An illustration of a **Keyed Expansion Joint** is also on Sheet 211 *(State Project H. 008244, Plaquemines)*. Consider an **8″** thick wall; use the table and the illustration to determine the responses to the following questions. Write the correct answer in the blank provided.

a. What is the chamfer depth? _____

b. How wide is the top of the key? _____

c. How wide is the bottom (B) of the key? _____

d. How deep is the key?_____

e. What is the thickness of the expansion material?_____

10-30. Other joints in the culvert require DOWELS. Look at the KEYED AND DOWELED EXPANSION JOINT illustration on Sheet 211. Notice the dimensions of the dowel read:

¾″ Ø x 2′ Long (Smooth) Dowels, ½ Length of Dowels to be Greased.

Turn back to Sheet 205 *(State Project H. 008244, Plaquemines)* in the Highway Plan Book. Locate **#6 Bars X** on both the **Plan and End Elevation** drawings. Notice that the spacing is 12″ O.C.

Find #6 Bars X under Wings and Curbs in the **Bill of Reinforcing Steel for 44′-0″ Culvert** table. A circle surrounding an “A” appears in the last column above the words “#6 Bars X.” This symbol refers to a notation found ***under*** the Bill of Reinforcing Steel for 44′-0″ Culvert table. It reads:

#6 Bars X to be ¾″ Ø X 2′ Smooth and Greased for 1'-0" of Length.

10-31. Locate **Sheet 210** *(State Project H. 008244, Plaquemines).* This plan shows a box culvert at an angle to the roadway with straight wing-walls. Review this sheet, and then refer to it after reading each of the following questions. Write the correct answer in the blank provided.

a. What is the angle of the culvert? _____

b. Look carefully at Section A-A. If the height of a barrel is 4′, does it require a construction joint where the top slab meets the barrel walls? *(yes or no)* _____

c. What part(s) of the culvert does $\mathbf{L_1}$ measure? _____

d. List the places on Sheet 210 where the height of the headwall (H) is found._____

e. Consider a 6′x6′ box culvert. What is the maximum allowable fill over the top slab? _____

f. The year plate is mounted on the _____.

g. All concrete must be ***Class*** _____. *(hint: find the General Notes)*

h. How much concrete is needed to construct a complete 5′x5′ x 44′-0″ box culvert? _____

i. How much steel is needed per linear foot of barrel to construct a 5′x5′ box culvert? _____

j. Consider a 5′x5′ barrel culvert. What is T? _____ What is Y?_____

k. What is the clear opening height for a 6′x6′ culvert? _____

l. Consider the End Elevation. What is the dimension given to locate the centerline of the weep hole? _____

10-31. *(continued)*

m. Fill in the data regarding **Bars A** for a **6′x6′ box culvert barrel**.

Size: _____ Number: _____ Length: _____ Spacing: _____

CATCH BASINS AND DROP INLETS

10-32. **Catch basins** and **drop inlets** are drainage structures that move surface water from the roadway into a drainage system as quickly and efficiently as possible.

A **drop inlet** is a specific type of storm and wastewater drainage inlet attached at the upstream end of a horizontal culvert, leading to a buried culvert or storm drain. The drop inlet can be constructed as a filter to prevent debris from entering the culvert and causing it to fail.

Catch basins generally are built along a street′s curb. Catch basins have a wide sloping inlet, which collects runoff, assuring that even when high volumes of water are being dumped into the system, there is minimal overflow. The inlet opens to a pipe, which is covered with a grating. The grating traps large debris, preventing it from entering the piping. As water floods the catch basin, small particles, which slip through the grate, settle to the bottom. Drainage pipes are located above the bottom of this vertical pipe, ensuring that the water flowing into the drains is clear of sediment.

10-32. ***(continued)***

Figure 10-14 *shows* a drop inlet compared to a box culvert.

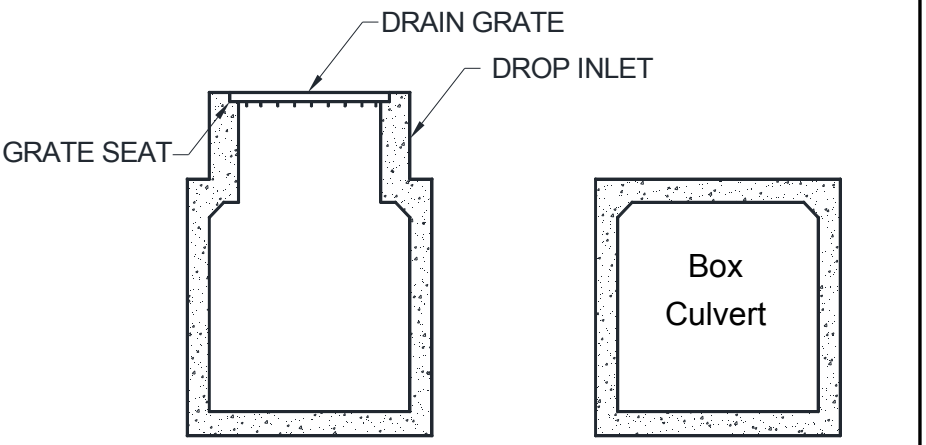


Figure 10-14

Figure 10-15 shows a longitudinal cross-section of a culvert with a ***drop inlet***, ***grate frame*** and ***drain grate***. Note how the drain grate and the grate frame fit in the ***grate seat,*** and then heavy asphalt fills the space.

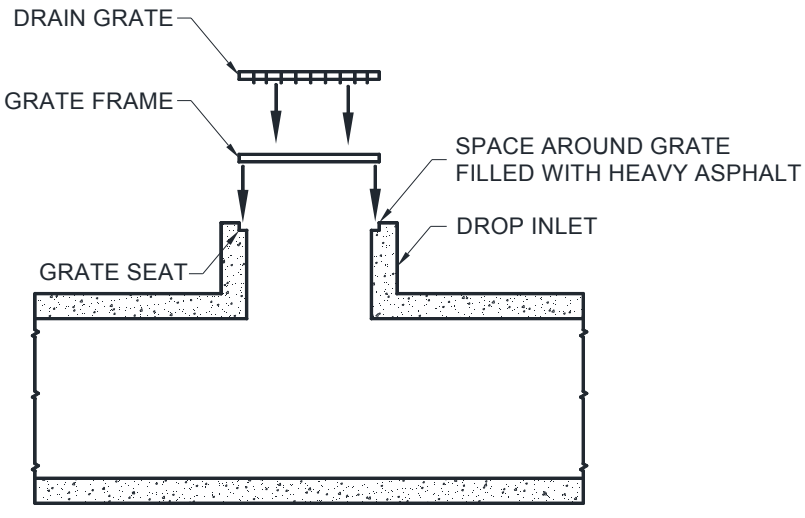


Figure 10-15

10-32. *(continued)*

Figure 10-16 shows the steps it takes to construct the **grate frame**.

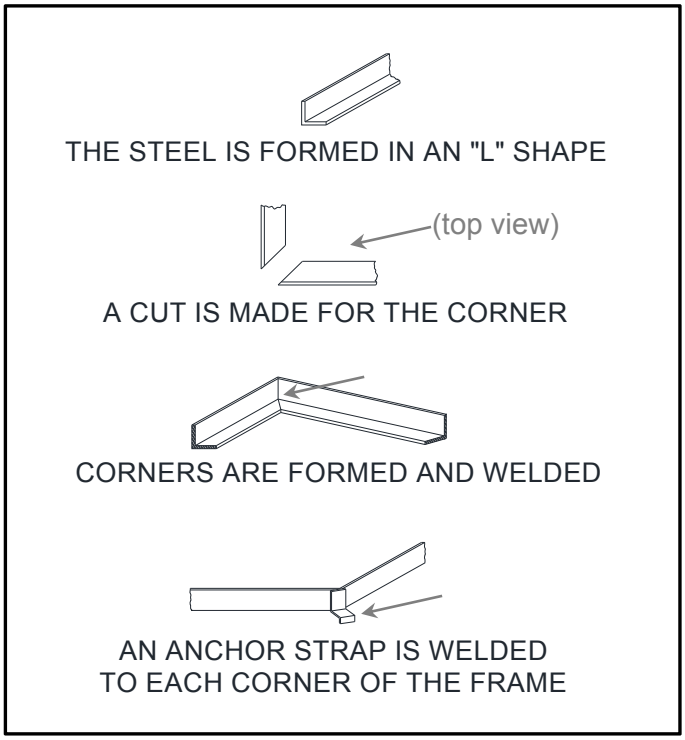


Figure 10-16

An integral part of drainage systems is the **catch basin.** ***Figure 10-17*** is a cross-section of a catch basin joining two pipes together. Surface water drains into the catch basin, then through the drainage pipes.

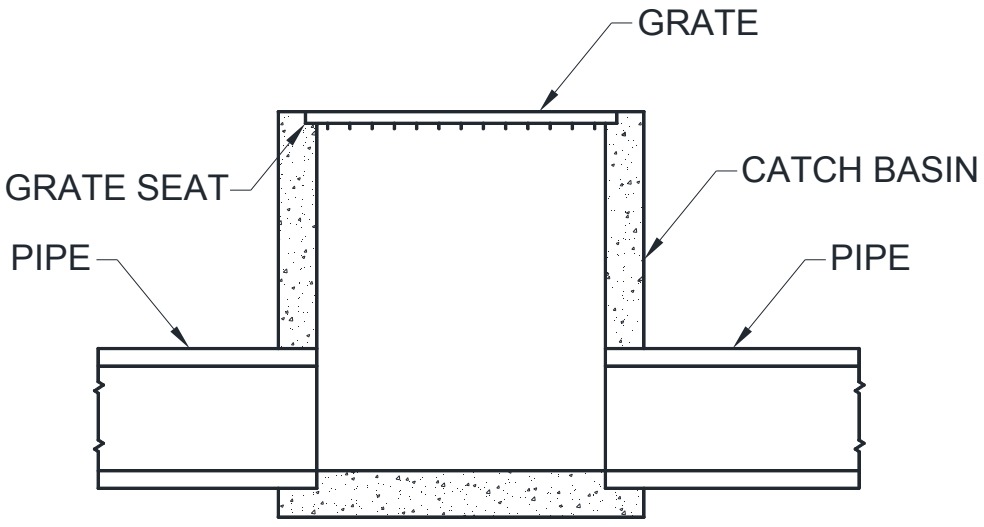


Figure 10-17

10-32. *(continued)*

Compare the catch basin (*previous page*) with the drop inlet shown on **page 10-24** *(Figure 10-14)*; note the similarities and differences.

Grates and grate frames designed for catch basins are constructed the same as grates and grate frames for drop inlets.

Fill in the blanks with the correct answers.

a. Which type of drain structure is attached on top of another structure allowing water to drain into the drainage system? *(drop inlet or catch basin)* _____

b. Which type of drain structure is part of, and connects other parts of the drainage system? *(drop inlet or catch basin)* _____

c. How many anchor straps are used with a square grate frame? _____

d. Are anchor straps welded or bolted to the grate frame? _____

e. What parts of the grate frame are welded? _____

f. The grate frame is seated in the _____ _____.
(hint: two words)

g. After the grate is placed in the grate frame, what substance is placed in the space around the grate? _____
(hint: see figure 10-15)

10-32. *(continued)*

Catch Basins and Drop Inlets vary in shape and size. Open the Highway Plan Book to Standard Plan **Sheet 202** *(State Project H. 008244, Plaquemines)*. This sheet shows typical catch basins.

Longitudinal and Transverse sections of a R.C. (*reinforced concrete)* Box Culvert on the right side of Sheet 202 show placement of the reinforcing steel within the top slab and walls of the inlet.

Recall the information from topic 10-21 with regard to “reading” rebar placement *(rebar size, quantity, length and spacing.)*

A plan view of a Drain Grate is in the top left corner of the sheet, complete with Cutting Plane lines depicting the locations of Sections A-A and B-B.

Cross-sectional views A-A and B-B appear in the bottom left corner of Sheet 202, each showing the catch basin, grate, grate seat and rebar placement, along with drain pipe specifications.

10-33. **Catch Basin depths** often differ because the distance between the bottom slab of the box culvert and the roadway surface can vary with each project.

Locate the **Dimensions Table** at the top of Sheet 202 *(State Project H. 008244, Plaquemines)*. Notice the varying basin depth dimensions. Dimensions X and Y (width and length) also vary depending on the basin depth.

Most of the Standard Plans show "poured-in-place" concrete for Drain Inlets and Catch basins. It is common now for Drain Inlets and Catch basins to be constructed from precast concrete; however, concrete "bricks/blocks" (CMU's) can be used if the plan specifications call for them.

Use the information found on Sheet 202 to fill in the blanks with the correct answers.

a. What is the thickness of the basin walls for a 6′ deep concrete basin?_____

b. What are the inside dimensions of the catch basin? _____

c. Read the notation under the Plan View on Sheet 202, when is a **Type "B"** grate used? _____

d. Locate the **vertical reinforcing bars "B"** in the walls of a catch basin. What size are these bars? _____

e. How far apart are Bars B in **Section A-A**?_____

f. How far apart are Bars B in **Section B-B**?_____

g. Do the vertical bars extend the full depth of the basin when they are not interfering with the pipe connection? _____

MANHOLES

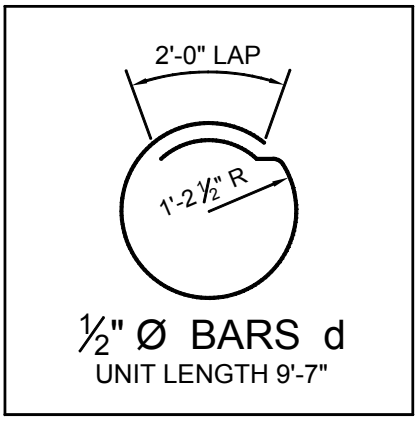
10-34. Turn to **Sheet 305** *(I-12, Dumplin Creek)* in the Highway Plan Book. It shows a reinforced **concrete manhole.** The purpose of a manhole is to allow access for inspection, maintenance, and alignment changes of drainage systems.

Manhole placements vary with pipe size. Certain size pipes specify how often a manhole needs to be placed along a length of drainage pipe. For instance, the Design Manual states that pipes 42″ or larger must have a manhole every 600 feet. Manholes also appear where there is a sharp grade change angle, pipe junction or a change in pipe size.

a. **Sheet 305** shows a manhole designed for use with a _____ maximum pipe connection.

10-35. Section drawings on **Sheet 305** designate rebar locations and specifications. Detail drawings and specification tables aid in acquiring information about individual pieces of rebar. Many times when reading plans it is difficult to obtain all the information about one particular item on these drawings. It is a good practice to make detailed lists when inspecting individual placement of the reinforcing steel.

Detail Drawing for **Bars d** taken from sheet 305



Find the detail drawing for "**Bars d**" *(look to the right of Section A-A).*

- Notice that **Bars d** are **½″** Ø and are configured in the shape of a circle or a hoop.
- An additional notation specifies that the length of each **Bar d** is 9′-7″ *(prior to forming.)*

10-35 *(continued)*

However, there is more information with regard to **Bars d**. Using the detail drawing titled **Bars d**, fill in the blanks below with the correct information

a. Size (diameter) _____

b. Length of each bar _____

c. Shape (round or square) _____

d. Radius of bend _____

e. How much lap is required? _____

10-36. Finding the location, spacing and the number of **Bars d**, requires reading the information found on the ***Bill of Materials for One Manhole*** table on Sheet 305 *(I-12, Dumplin Creek)* in the Highway Plan Book.

Look under the column heading "**MARK**," scroll down and find ***Bars d***. Follow that row to the right, and observe that some of the attributes about *Bars d* are repeated, and new attributes are added.

The table reveals that *Bars d* are placed 9″ on center, and are used as "hoops in walls of cylinder" (manhole).

Locate Section A-A, find ***Bars d*** (*hoops d*). Notice their location is near the top. This part of the manhole is cylindrical.

Find the dimension **V (variable)** in Section A-A. **V** is a ***variable measurement*** that depends on the depth of the manhole in the ground.

Look back at the ***Bill of Materials for One Manhole*** table; find ***Bars d*** under the column heading "***Mark***." Notice that the quantity *(number required)* of ***Bars d*** is actually the mathematical formula shown below.

$$\text{Number of Bars} = \frac{(V + 3")}{9"} + 1$$

10-36. *(continued)*

For example, suppose dimension V = 42″

$$\text{Number of Bars} = \frac{(42" + 3")}{9"} + 1$$

$$\text{Number of Bars} = \frac{(45")}{9"} + 1$$

$$\text{Number of Bars} = 5 + 1 \qquad \textbf{Number of Bars} = \textbf{6}$$

a. Calculate the number of ***Bars d*** required if **V= 78″**. Use the space provided to show your work.._____

b. Calculate the number of ***Bars d*** required if **V= 24″**. Use the space provided to show your work._____

Refer to Section A-A on Sheet 305 *(I-12, Dumplin Creek)* to answer the following questions.

c. What is the inside diameter of the manhole cylinder? _____

d. How thick are the cylinder walls of the manhole? _____

FENCES AND GATES

10-37. Turn to Standard **Sheet 306** *(I-12, Dumplin Creek)* in the Highway Plan Book. It shows a **barbed wire fence,** and a **combination mesh & barbed wire fence**. It also shows **single and double swinging driveway gates**, along with a **walk gate**.

Read and review the typical drawings, notes, and installation specifications for the fences, fence posts, braces, gates, etc.

Fill in the blanks below with the correct answer. Use the information found on Sheet 306.

a. List the two materials the department allows for gate construction.

_____

10-37. *(continued)*

b. The minimum required weight for a ***galvanized steel*** single swinging walk gate is _____.

c. The minimum required weight for an ***aluminum*** single swinging walk gate is _____.

d. What is the minimum length of a ***gatepost***? _____

e. What is the minimum length of a ***line*** post? _____

f. What is the distance from the ground to the top of a gatepost? _____

g. List the two alternate barbed wire gages that are permitted as long as their breaking strength exceeds 950lb. _____

h. The maximum distance between line posts is_____ feet on center.

i. How far above the ground is the bottom of the single-opening driveway gate?_____

j. How often is barbed wire stapled? _____

k. Braces shall be placed on straight sections of fences not more than _____ apart.

l. On a 5-strand barbed wire fence, the strands are _____ apart

m. The distance between the ground and the bottom of the 4″x4″ fence brace is _____

n. Gates are to open _____unless otherwise directed by the Engineer.

EMBANKMENT, FLEXIBLE REVETMENT and RIPRAP

10-38. A **berm** is an embankment used to stabilize the ends of a bridge structure. Berms are constructed between the bridge end of the approach slab and whatever obstacle (rivers, bayou, etc.) the bridge may span.

Revetment and **riprap** are installed on the berm slopes to prevent erosion (washing away) of the embankment.

10-38. *(continued)*

Revetment is an erosion control-process usually consisting of sacked concrete, stone or recycled concrete placed in an organized, stacked arrangement.

Riprap is another erosion control-process of placing stones, rocks, broken concrete, etc. in an irregular fashion.

Turn to Sheet 307 *(I-12, Dumplin Creek)*. It shows various views of an embankment. It also shows **Revetment,** and **Riprap** details.

- The **General View** at the bottom left of the sheet shows an overall view of the embankment slope protection.
- A typical section at the top left of the sheet shows sacked concrete revetment.
- A typical section at the top right of the sheet shows stone or recycled concrete revetment or riprap.
- Sections of the revetment end wall details are shown in the middle of the sheet.

Refer to the General View on Sheet 307 to answer the following questions.

a. Revetment or riprap is placed on the roadway embankment starting at the roadway _____ _____. *(hint: look at the top of the drawing)*

b. What is the purpose of a vertical stack in Section A-A?

_____

Use the Typical Section, *Sacked Concrete Revetment* to answer the following questions. Notice the geotextile fabric used under the sacked concrete to stabilize the embankment.

c. What is used at the “toe of the slope” to protect against erosion?

_____

d. Is the ground line or channel bottom above or below the double row of sacks?_____

e. How thick is the sacked concrete revetment? _____

10-38. *(continued)*

Use the Typical Section, *Stone or Recycled Concrete Revetment or Riprap* on Sheet 307 *(I-12, Dumplin Creek)* to answer the following questions. Notice that thickness "**T**" depends on the "Class" of riprap used in the table in the lower right hand corner of the plan sheet.

f. What is the minimum thickness "**T**" when recycled concrete is used?

_____

g. A berm is constructed for _____ purposes.

HIGHWAY SIGNS AND BARRICADE DETAILS

10-39. The Manual on Uniform Traffic Control Devices (MUTCD) sets the standard for the different types of signs, classifying them as **regulatory, warning, or guide**. Setting minimum standards and providing guidance, ensures uniformity of traffic control devices across the nation.

Sign classifications are defined by their function:

Regulatory signs give notice of traffic laws and regulations

Warning signs

- give notice of a situation that might not be readily apparent
- unexpected conditions on or adjacent to highways or streets.
- situations not readily apparent to individuals on the road.
- situations or conditions requiring a reduction of speed or an action in the interest of efficient, yet safe traffic operations.

Guide signs show route designations, destinations, directions, distances, services, points of interest, and other geographical, recreational, or cultural information.

10-40. The standard plan ***HS-01***, located on **Sheets 326 – 328** *(I-12 Dumplin Creek)* in the Highway Plan book reveals information relating to the various signs and barricades used on highway projects. Most often, these standard plans will indicate six specific details pertaining to each sign. They are:

- the intended use of the sign *(i.e. regulatory, warning, or guide)*
- the location (placement) of the sign.
- the color(s) of the sign.
- the size of the sign (dimensions)
- the department's code number for the sign *(i.e. W20-1; M4-9R, etc.)*.
- the height of the letters and numbers.

Figure 10-18 shows an illustration and qualifying information about the "**Road Construction 1500 FT**" sign taken from Sheet 326 *(I-12, Dumplin Creek).* This is one of the many examples shown on sheet 326. Read the information written above the "sign." Notice that this information does NOT include the color of the sign, or the letter height.

ADVANCE ROAD (STREET) CONSTRUCTION SIGN (W20-1)

The Road (street) Construction Sign is to be located in advance to the initial activity or detour a driver may encounter, and is intended for use as a general warning of obstructions or restrictions. It carries the legend ROAD (STREET) CONSTRUCTION ( ) FT. or ROAD (STREET) CONSTRUCTION ( ) MILE. It may be used in repetition with appropriate legends, or in conjunction with other construction signs

The legend ROAD (STREET) CONSTRUCTION AHEAD is intended mainly for use on approaches of road (streets) that intersect the route under construction in between the 500 ft. advance warning signs and the End Construction sign. It is also employed as the first advance sign in urban settings with short 250′ spacing.

W20-1

48″ X 48″

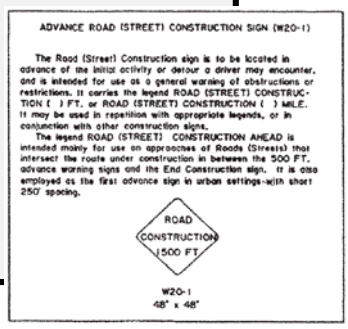


Figure: 10-18

10-40. *(continued)*

Turn to Sheet 326 *(I-12, Dumplin Creek)* in the Highway Plan book. Look at the note written above the title block in the lower right corner of the sheet. It reads:

> *NOTE:*
> *All signs on this sheet shall have orange backgrounds with black *legends and borders, except where otherwise specified.*

> * A sign Legend contains all word messages, logos, and symbol designs intended to convey specific meanings.

Whereas this note gives the background, border and legend colors, it does **NOT** express the height of the letters. For sign specifics, the department references the Manual on Uniform Traffic Control Devices (MUTCD), which in turn references the manual titled "Standard Highway Signs & Markings." Below, Figure 10-19 shows a page taken from the Standard Highway Signs and Markings manual with all the qualifying information for the warning sign **W20-1** (see figure 10-18). Both the MUTCD and the Standard Highway Signs & Markings manuals are available for download on the MUTCD website.

Here are the six specific details pertaining to the Road Construction 1500 feet sign.

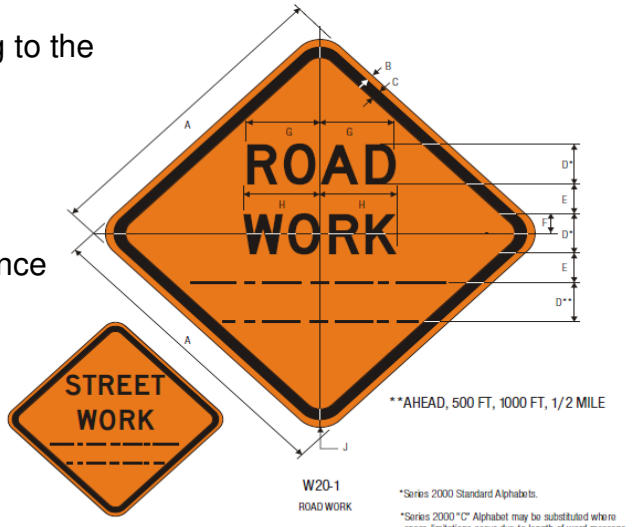
Intended use: Warning

Location: Between the 500 ft. advance warning signs

Colors: Orange and Black

Size: 48″ x 48″, letter size 7″

Code number: W20-1



	A	B	C	D	E	F	G	H	J
	24	.375	.625	4 D	2	2	6.685	6.965	1.5
	30	.5	.75	4 D	2.742	2	6.685	6.965	1.875
C	[illegible]	.625	.875	5 D	3.682	2.481	8.406	8.656	[illegible]
	48	.75	1.25	7 D	4.803	3.482	11.688	11.788	3
	60	.75	[illegible]	[illegible]	[illegible]	4	[illegible]	[illegible]	3

Figure: 10-19

10-40. *(continued)*

Fortunately, the majority of the signs displayed on Standard Plan Sheets 326, 327 & 328 reveal all six attributes. Figure 10-20 shows **R11-2,** a "Road Closed" Regulatory sign. The "***R***" in **R11-2** indicates that this sign is a Regulatory sign; the remaining five attributes are circled.

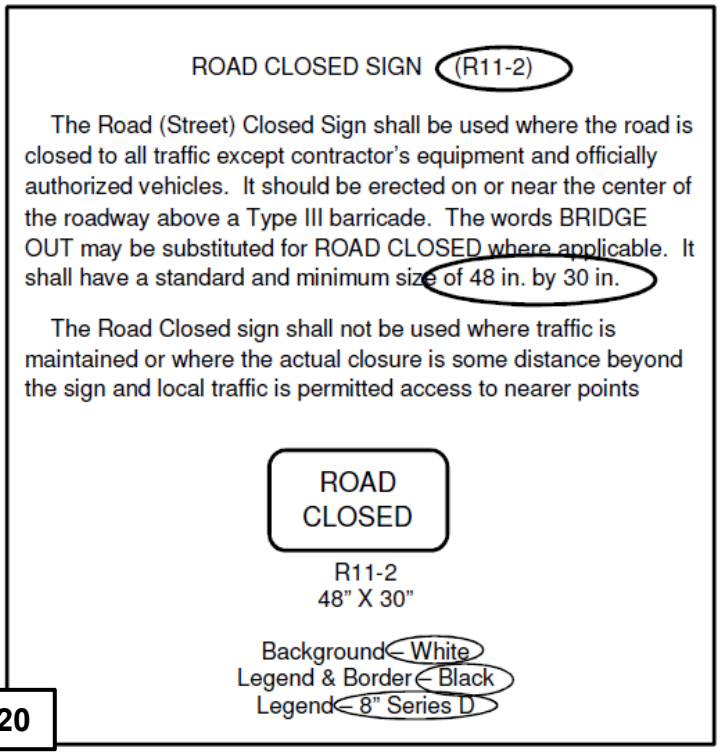


Figure: 10-20

Using Standard Plan Sheets 326, 327 & 328 *(HS-01)* locate the following signs. Read the qualifying information for each sign, then record the appropriate information about each sign in the blanks provided.

a. Intended use: _____

Location: _____

Colors: _____

Size:_____

Code number: _____

b. Intended use: _____

Location: _____

Colors: _____

Size:_____

Code number: _____

10-40. *(continued)*

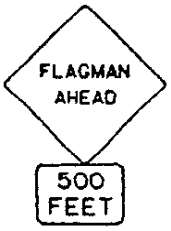
c. Intended use: _____

Location: _____

Colors: _____

Size:_____

Code number: _____



d. Intended use: _____

Location: _____

Colors: _____

Size:_____

Code number: _____

e. Intended use: _____

Location: _____

Colors: _____

Size:_____

Code number: _____

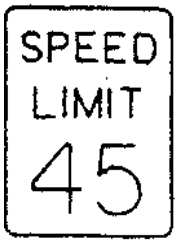
f. Intended use: _____

Location: _____

Colors: _____

Size:_____

Code number: _____



CHAPTER REVIEW QUESTIONS

Part 1.

List the components that **make up a box culvert barrel**.

a. _____

b. _____

c. _____

List the components that **make up the headwall** associated with a box culvert.

d. _____

e. _____

f. _____

g. _____

For questions **h – m**, there is an order (sequence) for pouring concrete when constructing a culvert. Write the number 1, 2, 3, or 4 to indicate which number in the construction sequence the following concrete culvert parts were poured.

h. Barrel top slab pour number _____

i. Barrel walls *(small walls)* pour number _____

j. Barrel bottom slab pour number _____

k. Footing (with toewall) pour number _____

l. Wing-walls pour number _____

m. Parapet pour number _____

n. Weep-holes allow water to drain out of the fill and relieve _____

o. Where are weep-holes located in a box culvert?_____

(hint - See Sheet 303)

CHAPTER REVIEW QUESTIONS *(continued)*

p. List 4 different headwall configurations.

_____

q. How many anchor straps are used with the grate frame shown on Sheet 202 *(State Project H. 008244, Plaquemines)*? _____

r. A berm is constructed for stabilization purposes. (true or false) _____

Part 2.

Refer to Sheet 301 *(I-12, Dumplin Creek)*, answer these questions about the reinforcing steel used to construct a **three-opening 6′x4′ culvert**.

a. Are Bars A used in the barrel or headwall. _____
b. Are Bars C used in the barrel or headwall. _____
c. Are Bars E used in the barrel or headwall. _____
d. Are Bars J used in the barrel or headwall. _____
e. Are Bars P used in the barrel or headwall. _____
f. Are Bars M used in the barrel or headwall. _____

Part 3. From Sheet 301, fill in the following data for reinforcing steel found in a **6′x4′, 2 opening culvert**.

		Size	No.	Length
a.	Bars A			
b.	Bars C			
c.	Bars E			
d.	Bars F			
e.	Bars J			
f.	Bars P			
g.	Bars N			
h.	Bars X			

i. What is the spacing for **Bars A**? _____

***Note**: Check your responses against answer sheets found at the end of this manual. If you missed MORE than three questions, review this chapter again and correct any wrong answers before progressing.*

TRAINING NOTES

TRAINING NOTES

CHAPTER 11
BRIDGE PLAN SHEETS

INTRODUCTION

Bridges are structures (including supports,) erected over depressions or obstructions such as water, highways or railways. Bridges are considered to have a minimum length of 20 feet, accompanied with a track or passageway designed to carry traffic *(people, vehicles, trains, etc.)* or other moving loads.

Title Sheets along with *Plan and Profile Sheets* show the location, length and finished elevations of a bridge; however, **Bridge Plan Sheets** contain **detailed information** regarding bridge construction.

Open the Highway Plan Book to the ***index*** found on the Title Sheet for *I-12 Dumplin Creek*. Notice that Bridge Plan Sheets are sheets **201-228**. Within these sheets are the results of **core borings**, **test piles**, detailed construction information about **approach slabs**, **bents**, **concrete decks,** and **caps**. A Bridge Plan sheet titled "**Summary of Estimated Quantities**" shows the quantity of each material required in the bridge construction.

BRIDGE TERMINOLOGY

11-1. Read each bridge term and its definition, and then refer to Figure 11-1 to find the component.

- **BENT -** the *supporting structure* of the bridge. **Piles** and **caps** are the two major parts of a bent. Figure 11-1 shows three bents, each with five piles and a cap.
- **PILES -** the *vertical* support members of each bent, driven into the ground.
- **CAP -** the *horizontal* support member of each bent. The superstructure of the bridge is built on top of the bent cap.
- **BERM -** an *embankment* constructed at both ends of the bridge, providing stabilization.

11-1. *(continued)*

- **SPAN** - is the *roadway over the bridge.* The *width* of a span is from one edge of the roadway to the opposite edge. Span *length* is the distance from the center of one *bent* to the center of the next bent.

- **BULKHEAD -** a *retaining wall* designed to hold back the fill on either side of the approach slab.

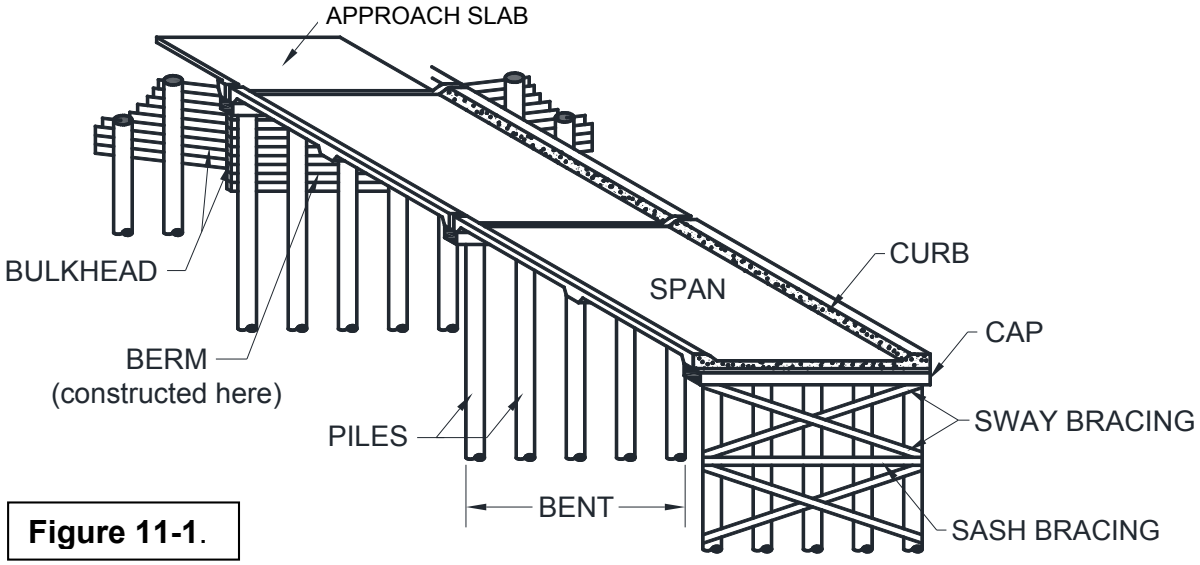


Figure 11-1.

- **SASH & SWAY BRACING -** placed between timber *piles* to reinforce the vertical supports and reduce the amount of vertical sway that occurs from the pressure of wind or water against the piles.

- **BARRIER RAIL** *(curbs)* **& GUARDRAILS -** the outside edge of the roadway extending the length of the bridge on both edges, designed to keep vehicles from going over (off) the edge in case of an accident.

CORE BORINGS AND TEST PILES

11-2. Prior to bridge construction, engineers require soil samples from the proposed bridge location. Two techniques are used to obtain the soil information. They are:

- An **auger** that sends up a continuous sample of soil as it digs into the ground. Information obtained from the auger samples are the primary source for making Soil Profiles.

11-2. *(continued)*

- A **boring device**, which is driven into the ground and upon removal, it brings up a plug or "core."

11-3. In order to find the correct depth (length) of the bridge piles, and the correct **design load** for the bridge, engineers require that **test piles** be driven into the ground prior to construction. Then, using a "**pile formula**," the load capacity of the test pile is determined, assuring that the bridge pile is set deep enough to bear the design load of the bridge.

Note: Pile Drive tests are done a second time before the contractor submits an order for bridge piles.

The *pile formula* expresses a relationship between the **load bearing capacity** (of a pile) and the **amount of energy required** to obtain each foot of ground penetration.

Determining the load bearing capacity is made using one of two formulas as specified in the plans, the **Dynamic Formula** or the **Wave Equation.** The *Dynamic Formula* is the preferred method (formula) for determining load bearing capacity if no formula is indicated on the plans.

Piles are driven with either a diesel hammer or external combustion hammer (ECH) such as hammers driven with steam, air or hydraulic power. Gravity drop hammers are only permitted to drive timber piles.

When driving the test piles there are ***three elevations*** of importance.

- the **ground elevation** at the point where the pile is driven.
- the **tip elevation** - the pile end being driven into the ground
- the **cut-off elevation** - the top of the bridge piles (as specified on the design plans.)

Consider a test pile driven 37.6 feet into the ground. At that depth, it is able to carry the design load. If the ground elevation is 50.0 feet, and the cut-off elevation is 82.4 feet. The calculations necessary to find the ***tip elevation*** and ***pile length*** are on the next page.

11-3. *(continued)*

- the tip elevation = 50.0′ - 37.6′ = 12.4′ (ground elevation minus depth)
- bridge pile length = 82.4′ - 12.4′ = 70′ (cut-off elevation minus tip elevation)

Answer the following questions, write the correct response, or calculation in the blank provided.

a. Test piles are driven to determine the _____ of the _____.

b. Pile bearing capacity is calculated by using the appropriate _____.

c. The pile formula expresses a relationship between load bearing capacity and the amount of _____ required to obtain each foot of _____ into the ground.

d. List the various types of hammers used to drive piles._____
_____

e. The elevation at the top of a bridge pile is called_____.

f. Suppose a 65-foot bridge pile is driven into the ground until it reaches a tip elevation of 15.5 feet. What is the cut-off elevation of the bridge pile? _____

g. Consider a test pile driven 26.5 feet into the ground. At that depth, it is able to carry the design load. The ground elevation is 61.1 feet, and the cut-off elevation is 93.5 feet. What is the tip elevation? _____
What is the length of the bridge pile? _____

11-4. Open the Highway Plan Book to Sheet 208 *(I-12 Dumplin Creek.)* This sheet contains **Pile Data** and **Bent Elevation** tables. Design engineers have recorded the data in these tables for each bridge pile.

Notice the column headings on the *Pile Data* tables.

- The first column contains a **Bent number** (this number corresponds to one of the two drawings shown above, or to the right of the table on sheet 208).
- Column 2 refers to the **Station Numbers** at each Bent.
- Column 3 shows a **pile number for each pile**. Take note that Bent 1 has 12 piles, and the rest have 11 piles. Each is numbered 1 through 11 or 12.
- Column 4 shows the **Plan Tip Elevation** *(notice the minus sign.)*
- Column 5 shows the **Cut-Off Elevation**

11-4. *(continued)*

- Column 6 shows a Plan Pile **Length of 60′** for each pile in every bent.
- Columns 7 and 8 are blank.
- The last column indicates a **Maximum Pile Load** of 49 tons for each pile in every bent.

Refer to the information found on Sheet 208 *(I-12 Dumplin Creek.)* **Answer the following questions; write correct answer in the blank provided.**

a. What is the cut-off elevation for **Pile number 1, Bent 1**? _____

b. What is the planned length of **Pile number 5, Bent 2**? _____

c. What is the planned tip elevation for **Pile number 4, Bent 3**? _____

List the station number for each bent.

d. Bent 1: _____

e. Bent 2: _____

f. Bent 3: _____

g. Bent 4: _____

h. Bent 5: _____

i. Bent 6: _____

j. What is the Center-to-Center distance between bents? _____

11-5. Turn to almost the end of the Plan Book to find Sheet 108 *(Youngs Bayou Bridges).* This sheet contains three tables of **Soil Boring Logs** and **Test Piles** data. Each **Core Boring** data table has **Soil Descriptions** *(soil, type, and color)* as the first column heading. Notice that the terminology is similar to the information found on Sheet 130, the *Subgrade Soil Survey (from Chapter 9.)* The other columns contain the following data.

- Column 2 indicates **Wet Density**

11-5. *(continued)*

- Column 3 indicates **Moisture Content**
- Column 4 indicates **Liquid Limit**
- Column 5 indicates the **Plasticity Index**
- Column 6 indicates "**qu**", which references soil consistency
- Column 7 indicates results of the **Standard Penetration Test**
- Column 8 indicates **Failure Mode** notations *(e.g. S/S = "Slickensides")*
- Column 9 indicates the **Sample Number**
- Column 10 indicates the **Depth**
- Column 11 indicates the **Elevation**
- Column 12 shows the **Water Table** information

11-6. Locate the **Station Numbers and Locations** at the bottom of the table on the left. Note that Boring No. 1 is located at **Station Number 103 + 91, 7′ RT CL west service Rd** *(interpreted as: 7 feet right of the centerline on the west service road.)* Notice that there are also **Longitude** and **Latitude** coordinates further verifying the site location of Boring No. 1.

Look at the **Soil Boring Logs** and **Test Piles** data from Sheet 108 *(Youngs Bayou Bridges)*; **fill in the blanks below with the correct answers.**

a. Record the station number and location of core borings 2 and 3.

Boring No. 2 - station number_____ location _____
Boring No. 3 - station number_____ location _____

11-7. Several abbreviations appear throughout Sheet 108 *(Youngs Bayou Bridges)*. For example, **Boring No. 1, Sample C62** has a soil type and color of **Gr Sa Cl**. Using the **Standard Abbreviations & Definitions** table at the bottom of sheet 108, *Boring No. 1, Sample C62 has a soil type and color of **Gray Sandy Clay**.*

Gr = Gray
Sa = Sandy
Cl = Clay

a. Record the color and soil type for **Sample D9** from **Boring No. 3**._____

b. Record the color and soil type at **Elevation 18.8, Boring No. 2**. _____

11-8. "**qu**" is "unconfined" compressive strength (AASHTO T 208, ton per sq. ft.,) and is expressed as a number. The abbreviation **qu** also appears on Sheet 108 in the "**Correlation of Penetration Resistance and Soil Properties (CPRSP)**" **table.**

- Notice the **qu** for Sample C58 from Boring No. 1 is **1.91**.
- Using the CPRSP table, 1.91 indicates that the soil at Sample C58, Boring No. 1 is a ***"stiff consistency of clay."***

a. What is the consistency of the soil for **Sample C83, Boring No. 2**?

_____

11-9. **Continue to reference Sheet 108** *(Youngs Bayou Bridges)*. **Fill in the following blanks with the correct answers.**

a. What is the plasticity index of Sample C4, Boring No. 3? _____

b. Sample C55, Boring No. 1 has a moisture content of _____.

c. Find the sample with an elevation of –31.4 feet *(minus 31.4 feet).* What is its soil consistency?_____

d. What is the moisture content of the soil sample from question **c**? _____

e. What is the liquid limit of the soil sample from question **c**? _____

Use the **Standard Abbreviations & Definitions** table on **Sheet 108;** then record the correct definitions for each abbreviation.

f. BL. _____

g. BK. _____

h. BR. _____

i. GR. _____

j. WH._____

k. YE._____

11-9. *(continued)*

l. CL. _____

m. SA. _____

n. M.S. _____

o. YLD. _____

p. S/S _____

APPROACH SLABS

11-10. **Approach Slabs** are slabs of concrete connecting roadways to bridges. Although they may vary in size, most approach slabs are similar. Concrete bridges with concrete decks utilize approach slabs.

Steel bars reinforce the concrete approach slabs. Open the Highway Plan Book to **Sheet 109**, *(Drain Canal Bridges, S.P. H. 000238)*. Observe the numbers *(e.g. 406, 701, etc.)* shown throughout the two Plan Views. These plans show the reinforcing steel placement locations in the top and bottom of an approach slab.

Notice too that there are several *cutting-plane lines (e.g. A-A, B-B)* throughout the sheet indicating several detail and section drawings. Turn to **Sheet 110**, *(Drain Canal Bridges)*. It shows these **detail and section drawings**.

A table in the upper right corner of Sheet 110 shows the **estimated material quantities** for an approach slab. Columns in the table show quantity, size, and descriptions for each piece of numbered steel. It also shows the estimated amount of concrete needed in terms of square yards, not cubic yards. It also indicates the total linear feet of Seals and Saw Cuts. Note that the table is set up to give quantities for only ***ONE*** approach slab.

Refer to Sheets 109 and 110 *(Drain Canal Bridges)*. **Answer the following questions then write the correct answer in the blank provided.**

a. How thick is the **joint material** between the approach slab and bridge span?_

b. List the type of material required to fill the joint. _____

11-10. *(continued)*

c. Consider the joint and joint material from question "a", what is its overall length? _____

d. One approach slab requires _____ pounds of **deformed** reinforcing steel.

e. How many square yards of concrete are required to complete **two** approach slabs? _____

f. Record the **total** length of approach slabs. _____

g. Approach slabs connect _____to _____.

BRIDGE GENERAL PLANS

11-11. Open the Highway Plan Book to the Bridge General Plan Sheet 104. *(Drain Canal Bridges, S.P. H. 000238.)* This is one of four general plans **showing *plan and profile drawings*** of the Drain Canal Bridges project, sheets 103 and 104 show details for the east and westbound lanes of Bridge Site 1, and sheets 105 and 106 show details for the east and westbound lanes of Bridge Site 2. Previous sheets provided specific details, and drawings for many different components of the bridge. General Plan sheets show the ***whole*** bridge, complete with notations, dimensions, and tables.

Review Sheet 104; **place a check** in the box as you find each item on the list.

- ☐ Bridge name
- ☐ Highway name
- ☐ Highway number
- ☐ Parish
- ☐ State Federal project nos.
- ☐ Begin station of the bridge
- ☐ End station of the bridge
- ☐ Bridge length
- ☐ Revetment
- ☐ Seeded areas
- ☐ Cut and fill
- ☐ Number of concrete spans
- ☐ Length of each span
- ☐ Length of each approach slab
- ☐ Percent grade for this bridge
- ☐ Station numbers for each bent

Answer the following questions utilizing the information from Sheet 104; write the correct answer in the blank provided.

a. What is the 50 year design D.W.S. elevation?_____

b. What is the slope rate of the flexible revetments? _____

11-11. *(continued)*

c. What will be the elevation at the bottom of the channel (water)? _____

d. How many catch basins are shown on this sheet?_____

e. What is the design speed?_____

f. How many bents are on this bridge? _____

g. What direction does the water flow? _____

h. What is the clear width of the West bound bridge traffic lane? _____

i. What is the center-to-center distance between the bents? _____

j. How deep are the proposed saw cuts? _____

k. What table shows guard rail information? _____

SUMMARY OF BRIDGE QUANTITIES

11-12. Open the Highway Plan Book to Sheet 102 *(Drain Canal Bridges, S.P. H. 000238).* Sheet 102 contains a table titled **Summary of Estimated Bridge Quantities**.

- Column 1 shows an **Item Number**, which identifies the section and subsequent paragraph(s) in the **Standard Specifications Book** covering this ***item of work***.

- The remaining columns are relatively self-explanatory, giving item descriptions, unit identification, and quantities.

However, notice the letters "**NS**" toward the bottom of column 1. ***NS*** signifies a **non-standard item**; an item not specified in the *Louisiana Standard Specifications for Roads and Bridges*. Such items require special provisions to describe the work required of the contractor; these additional provisions are inserted into the contract proposal.

Another interesting series of numbers (e.g. ***02260051001311****)* appear in the row beneath the column headings *"Site 1 and 2"*

- ✓ Recalling the State Project numbering system from Chapter 2, helps understand this number.

Look at the breakdown *(next page)* of the number *02260051001311*, it is part of a numbering system created to accurately process, track, and acquire statistical data for each State Project.

11-12. *(continued)*

Breakdown of the number 02260051001311 (02 26 00510 0131 1)

District	Parish	Control Section	Log Mile	Unique Number
02	26	005.10	01.31	1

11-13. Look under the Item Description column on Sheet 102, the Summary of Estimated Bridge Quantities. Notice the many different construction processes taking place: the removal of approach slabs, debris removal, excavation, catch basins, etc.

Answer the following questions utilizing the information from topic 11-12 and Sheet 102. Write the correct answer in the blank provided.

a. What is the total amount of concrete approach slabs being removed? _____

b. How many linear feet (total) of guardrail are to be removed? _____

c. How many catch basins are there for the entire project? _____

d. How many linear feet of 18″ bridge drains does Site 1 require? _____

e. What do the letters “NS” represent? _____

f. Given the number *03371162112422*, record the control section._____

g. What station number is associated with the side drain pipe 18″ x 43′?_____

h. What is the total LF of storm drain pipe needed for State Project H.000238?_

i. How many CU.YDS. of embankment are used for estimating purposes? ____

j. What is the unit measure associated with superpave asphaltic concrete?___

k. Does this summary include an amount for flexible revetment?_____

l. How many linear feet of perforated pipe are needed for both sites? _____

PRECAST-PRESTRESSED CONCRETE PILES

11-14. Open the Highway Plan Book to Sheet 122 *(East & West Carroll, S.P. H. 001957)*. This sheet shows construction details for **precast-prestressed concrete piles**. Precast and prestressed piles are manufactured off site then delivered to the project.

Spiral reinforcing steel is incorporated into the concrete to strengthen the overall structure of a pile. Spirals can be square or circular (**Figure 11-2**). Presently, the department only specifies the use of square spiral configurations of reinforcing steel for square or rectangular concrete piles.

Figure 11-2 also shows the approximate placement of **Vertical Steel Tensioning Strands** integrated with the spiral rebar configuration. This combination is used to reinforce the length of square or rectangular concrete piles.

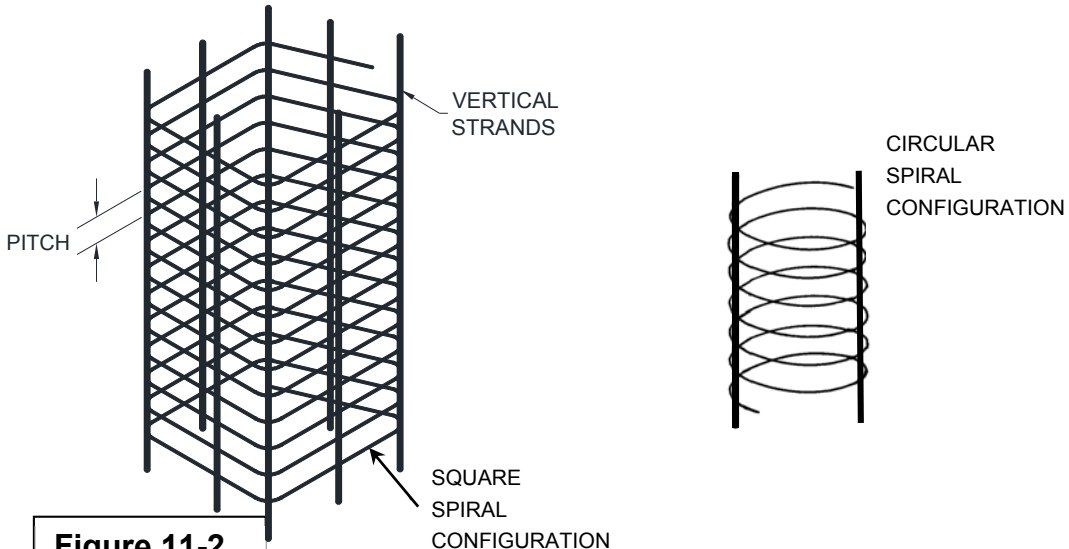


Figure 11-2

Notice the spiral reinforcing steel placement in the cross-section drawing (Sheet 122) located in the upper left corner of the sheet.

Read the note at the left end of the drawing, it reads, **5 turns @1″ = 5″**. This is interpreted as *five spirals with a pitch of 1 inch over a distance of 5 inches,* with **pitch** being the distance between each spiral. (see Figure 11-2)

Look closely at the cross-section drawing on Sheet 122, the spirals are closer together on the ends, then spaced farther apart as the steel continues to the center of the pile. See **Figure 11-3** on the next page**.**

11-14. *(continued)*

Figure 11-3

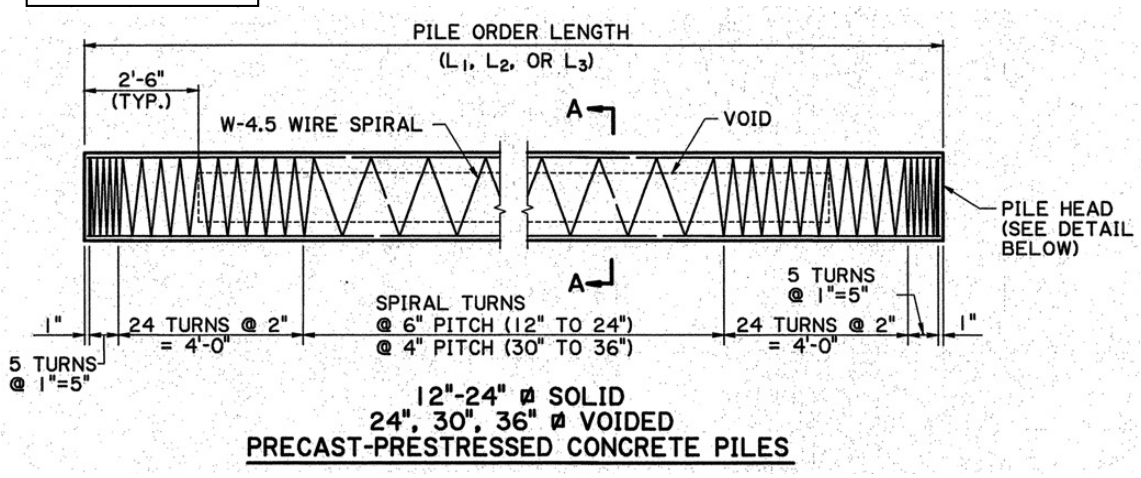
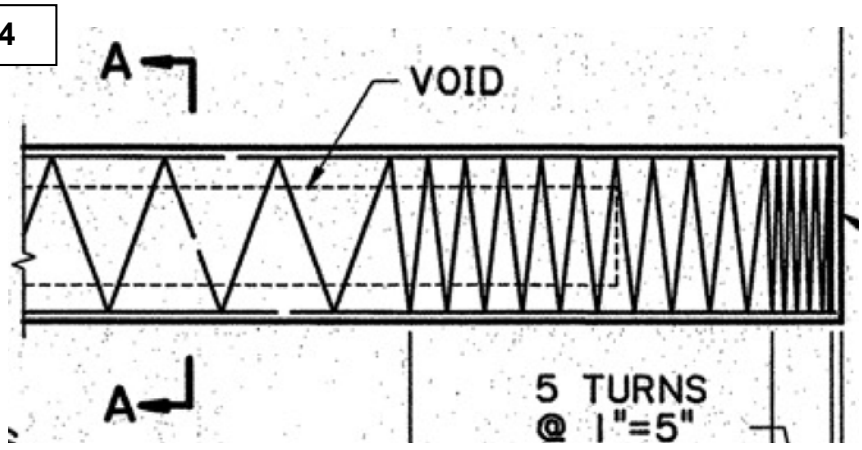


Figure 11-3 is an illustration taken from sheet 122 *(East & West Carroll)*. Observe that the **pitch** (distance) between spirals increases to 2 inches over the next 4 feet, then increases again as the steel approaches the middle of the pile.

Another note under the drawing indicates that piles with a diameter between 12 and 24 inches are **solid**, while 24, 30, and 36-inch diameter piles are "**voided**."

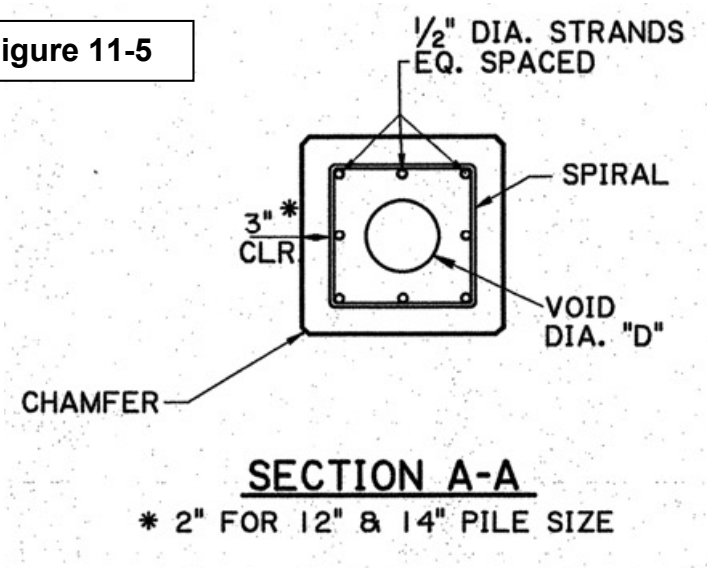
Figure 11-4



Notice the dashed, hidden lines in the cross-section. These hidden lines represent a "**void**," a hollow spot within the center of the pile **(Figure 11-4)**.

11-14. *(continued)*

Figure 11-5



To the right of the cross-section is **Section A-A** showing "**D**" as the *diameter of the void*. "D" or "d" corresponds to the **Pile Information** table at the bottom of Sheet 122. See **Figure 11-5**.

Locate the **Pile Information** table, look under the **Section Properties** category. Notice the numbers in the column beneath this heading → **VOID "d" (in.)** it shows the void diameter for 24″, 30″, and 36″ piles.

Look back at the hidden lines in the cross-section; notice that they stop 30″ short of each pile end (as indicated in the Pile Head Detail, **Figure 11-3**). This means that the void is not a through void, but stops 30″ short of each end of the pile. Notice too that the **Pile Head Detail** shows a small 2-inch diameter "vent" hole appearing on the face of each voided pile.

11-14. *(continued)*

Read the **General Notes** located in the upper right hand corner of Sheet 122 *(East & West Carroll)*. It includes many instructions, specifications, and details ranging from concrete strength, to the pick-up and handling of the piles.

Refer to the drawings, tables, and general notes on Sheet 122, *(East and West Carroll)* **to answer the following questions, then write the correct response in the blank provided.**

a. List the three pile sizes (Ø) that have a hollow void._____

b. Interpret the following note: *24 - Turns @ 2″ = 4'- 0″* _____

c. What is the chamfer distance for a pile with a 12″ diameter?_____

d. Consider an 18″ diameter pile: what is the pitch of spiral steel at the midpoint of the pile length? _____

e. Measured 20″ from the end of a 36″ Ø pile, how far apart is each spiral? ___

f. Does the cross-section *(for precast-prestressed concrete piles)* indicate that the spiral spacing, and the number of turns *are the same* for both ends of the pile?_____

g. What is the recommended size (Ø) of the spiral reinforcing steel? _____

h. What is the void diameter (D) for these two piles? 24″ _____ 30″_____

i. Record the weight per linear foot of a 24″-voided pile. _____

j. How many ½″ Ø, 7 wire - Grade 270 reinforcing steel strands are required for a 16″ solid pile with spiral reinforcement? _____ *(hint: read the General Notes, then review the Pile Information table.)*

k. How many inches of space are there between the edge of a 14″ pile and the "square" spiral steel? _____*(hint: see note near Section A-A)*

l. How many pounds per square inch (*initial tension/prestress force)* are applied to each ½″ Ø, 7 wire - Grade 270 reinforcing steel strand? _____

(hint: read the General Notes)

CHAPTER 11 REVIEW QUESTIONS

Answer the following questions then write the correct answer in the blank provided. Some questions will require referencing the written material from this chapter, while others require interpretation of Sheets 121 & 122 *(East & West Carroll)***, Sheet 108** *(Youngs Bayou)***, Sheets 102, 104, 106, 109 & 110** *(Drain Canal Bridges)* **and Sheet 208** *(Dumplin Creek)*

a. Test piles are driven to determine the required _____ of bridge piles.

b. The load bearing capacity of a test pile is calculated by using a _____.

c. Does the spiral reinforcing pitch ever change? _____ where? _____

d. A bent is made up of _____ and a _____.

e. The superstructure of the bridge is built on top of the _____.

f. What connects the bridge to the roadway at each end of the bridge? _____

g. Precast and prestressed piles are _____ then delivered to the project.

h. If each bent had 10 piles, how many piles would be necessary for the construction of a 15 span bridge? _____

i. How many bents are in a 15 span bridge? _____

j. How many pick-up points are associated with the note L_1 on sheet 121*(East and West Carroll)*?_____

k. Bridge Plan Sheets contain _____ regarding bridge construction.

l. Consider Sheet 106 *(H. 000238)* how many piles are associated with the center bent? _____

m. Consider Sheet 106 *(H. 000238)* what is the length of each approach slab?_____

n. All 36″ diameter piles are solid. _____ (True or False)

CHAPTER 11 REVIEW QUESTIONS *(continued)*

o. Name the vertical supporting member of a bent. _____

p. Name the horizontal supporting member of a bent. _____

q. What provides stabilization at the ends of a bridge? _____

r. What is the name of the retaining wall that holds back the fill on either side of the approach slab? _____

s. _____ is the roadway over the bridge.

t. The width of a span is from _____ of the roadway to the _____.

u. The length of a span is from the center of one _____ to the center of the next _____.

w. The curb and guardrail are designed to keep vehicles from going over the edge in case of _____.

x. Bracing is placed between _____ to reinforce the vertical supports.

y. List two types of pile bracing. _____ & _____

z. _____ is incorporated into the concrete to strengthen the overall structure of a **pile**.

***Note**: Check your responses against answer sheets found at the end of this manual. If you missed MORE than three questions, review this chapter again and correct any wrong answers before progressing.*

TRAINING NOTES

CHAPTER 12

SUMMARY SHEETS

INTRODUCTION

Plan sets include many different types of information. At times, it is necessary to know details pertaining to a specific material, component, action, quantity, or location. **Summary Sheets** group and total all the project materials, listing quantities scheduled for installation or removal. Also included on Summary Sheets are Station numbers showing the location of the proposed work.

Three different places within the plan set contain Summary information.

- **Summary Sheets** - usually placed close to the front of the plan set.
- **Summary of Drainage Structure Sheets** - found among the *Drainage Sheets*.
- **Bridge Summary Sheets** - found among the *Bridge Plan Sheets*.

This chapter will reference Summary Sheet material from both State Project H. 000238 *(Drain Creek Bridges on U.S. 90)* and State Project, 268-01-0012, (*I-12 – Dumplin Creek*.)

Throughout the chapter, consecutive **TOPIC** numbers indicate various facets of information pertaining to Summary Sheets. Occasionally, topic numbers will reference one another.

As in previous chapters, review questions relating to the subject information appear periodically. Complete each question, as they will become useful study guide material.

SUMMARY SHEETS

12-1. Look at the index on Sheet 1 for State Project H. 000238 *(Drain Creek Bridges on U.S. 90)*. Notice that the page numbers for the **Summary Sheets** are 3 – 3a.

Also, note that sheet **3b** is the Summary of Estimated Quantities, and Sheet 102 is the Summary of Bridge Quantities. The Summary of Bridge Quantities Sheet is usually the first sheet of the Bridge Plan Sheets.

Review Summary Sheets 3 – 3a. There are several tables containing specific **Items of work**, and summary information. Each table also has a specific name, e.g., Earthwork, Base and Wearing Course, Temporary Erosion Control, etc.

Notice that the first two columns in each table contain "Station" numbers. These show the location of the proposed work. This helps both LADOTD, and bidders locate an Item of work.

Refer to Sheet 3a *(State Project H. 000238, Drain Creek Bridges on U.S. 90.)* **to answer the following questions, write correct answers in the blanks provided.**

a. How many Summary Tables are on Sheet 3a? List them.

_____

b. Record the State Project number(s) found on Summary Sheet 3a. _____

c. What is the total linear feet of Curbs scheduled for removal? _____

d. How many cubic yards of Asphaltic Concrete are scheduled to be retained?

_____

e. How many linear feet of Guardrail between Station 208 + 71.86 and Station 210 + 80.26 are scheduled for removal?_____

f. How many miles Solid Line Permanent Pavement Markings are scheduled to be installed between Station 202 + 91.91 and Station 205 + 30.50? _____

g. How many square yards of Cold Planing are scheduled for the Left Side of the centerline between Station 209 + 21.91 and Station 209 + 61.91?_____

12-1. *(continued)*

h. Write T (true) or F (false) beside the statement:

_____ 208.4 linear feet of Guardrail on the **left side** of the centerline between Stations 208 + 71.86 and 210 + 80.26 are scheduled for removal.

SUMMARY OF ESTIMATED QUANTITIES (PAY ITEMS)

12-2. Whereas the first few Summary sheets deal with quantity, Sheet 3b, the **Summary of Estimated Quantities**, shows **Item numbers, Descriptions of Work, Units,** and the *estimated* **Quantity of Materials.** The *estimated* Quantity of Materials are usually recorded in whole units, and rounded up, unless it is measured "lump."

Sheet 3b contains **all** the estimated quantity information for each project. The total quantity recorded in the table takes into consideration Item quantities from the Drainage and Bridge summarization sheets. Sheet 3b is a useful table during the preparation of a bid, as it describes the **method of payment** for each Item (i.e. lump, square foot, etc.) This allows the department to compare, and track how different contractors bid for any particular Item.

Locate the **Item number** column on Sheet 3b. Note that the first three digits correspond to the numbered sections found in the *Louisiana Standard Specifications for Roads and Bridges*.

These are column headings for the Summary of Estimated Quantities.

- **Item numbers** that correspond to the *Louisiana Standard Specifications for Roads and Bridges* numbering system. Sometimes **Item numbers** are referred to as *Pay* Item numbers.

- **Item description** describes the action or work to be performed

- The **Unit** column describes the measure of each Item e.g., square yards, tons, linear feet, each, lump sum, etc. This is the "unit measure" for how items are paid.

12-2. *(continued)*

- The **Quantity Total** column provides the total number of Units for each Item.

Locate **Item 204-02-00100** in the left column, then, scanning to the right, read the Quantity Total. Notice that 56 bales of Hay or Straw are estimated to be used on this project.

Refer to Sheet 3b *(State Project H. 000238, Drain Creek Bridges on U.S. 90.)* **to answer the following questions**, **write correct answers in the blanks provided.**

a. Record the number of Reflectorized Raised Pavement Markers required for this project. _____

b. What is the Item number for Flexible Revetment? _____

c. 702-03-00100 is the Item number for _____.

d. How many linear feet of Temporary Silt Fencing are required for this project? _____

e. How much Hydro Seeding is necessary for this project? _____

Refer to Sheets 3f and 3g *(State Project, 268-01-0012, I-12 – Dumplin Creek)* **to answer the following questions, fill in the blanks with the correct answers.**

f. What is Item number 717(01)? _____

g. What is the total quantity of Item 717(02)?_____

h. What is the Unit measure for Item 706(01) (A)? _____

i. How many Project Site Laboratories are required? _____

j. The Unit measure for Water is _____

k. How much Water is required? _____

l. The Unit measure for Asphaltic Concrete is _____

m. The Summary of Estimated Quantities describes the method of payment for each _____

n. What is total amount of proposed Asphaltic Concrete for all 3 parts *(State Projects)* of this project? _____

12-2. *(continued)*

o. How many (CB-01) Catch Basins are required for State Project 268-01-0012?

_____

p. What is Item 701 (04) E? _____

q. List the Item number(s) describing the Item, "Cross Drain Pipe Arch."

_____

r. List 6 Item numbers on Sheet 3g with the Unit measure "Square Yards."

1. _____ 3. _____ 5. _____
2. _____ 4. _____ 6. _____

s. Given the information on Sheet 3g, is a relocation of a "Cattle Guard" scheduled? (yes or no) _____

SUMMARY OF DRAINAGE STRUCTURES

12-3. Locate the **Summary of Drainage Structures** sheets 46 – 55, *(State Project, 268-01-0012, I-12 – Dumplin Creek)* in the Highway Plan Book.
Summary of Drainage Structures sheets show the Location, Plan (sheet) number, Type of structure, Size, and Quantity for each Drainage Structure. These plan sheets are located near the *Plan and Profile*, *Drainage Cross Section*, and *Drainage Detail* sheets for cross-reference purposes.

Look for these column headings on sheet 46.

- **Station numbers** – listed in consecutive order.
- **Remarks** – describing each Drainage Structure
- **Plan** – references to Plan Detail Sheets or Sheet numbers.
- **Type** – shows abbreviations for the various Drainage Structures.
  (*e.g., SD = Side Drain*)

The remaining columns show numerical quantities needed per Pipe, Pipe Arch, Catch Basin, Manhole, etc.

12-3. *(continued)*

Refer to Sheet 47 *(State Project, 268-01-0012, I-12 – Dumplin Creek)* **to answer the following questions, fill in the blanks with the correct answers.**

Look under **Remarks** column and locate the Storm Drain Pipe - **18″ X 64′.**

a. What is the Station Number for this structure? _____

b. List 2 types of pipe allowed for question "a" _____

c. What "Type" of Drainage Structure is at Station 138 + 30? _____

d. Record the length of Side Drain Pipe needed at Station 128 + 11. _____

e. What is the diameter of the Side Drain required at 132 + 10.69? _____

f. What Standard Plan shows the details for the Catch Basin at Station 140 + 31? _____

g. Sheet 47 shows Summary information for _____ Manholes RT (*how many*.)

12-4. The Summary of Drainage Structures, Sheet 55 *(State Project, 268-01-0012, I-12 – Dumplin Creek)*, continues to show information for other Drainage Structures at different Station Numbers.

Sheet 55 includes Sub-totals and Totals for all 3 of the State Projects associated with "SP *268-01-0012."*

There are 2 more tables on this sheet. One specifies the "Gage" requirements for Side Drains, and the other defines drainage structure and pipe abbreviations.

Use ALL the information on Sheet 55 to answer the following questions, fill in the blanks with the correct answers.

a. What is the minimum service life required for the Metal Pipe? _____

b. C.D.P.A. is an abbreviation for _____.

c. How many Standard Plan, CB-01- Catch Basins are listed in the row titled "Totals for All Projects"? _____

d. How many linear feet of 18″ Side Drain Pipe are required for S.P. 013-06-0034? _____

e. List the Station Number(s) requiring 30″ Cross Drain Pipe Arches.

_____

12-4. *(continued)*

f. How many linear feet of 30″ Eq. Storm Drain Pipe Arch are required for the State project 268-02-0014? _____

g. What are the allowable dimensions for a **Pre-Cast** Catch Basin or Manhole?

_____

Given the following Drainage Structures, record the total quantity required for each on SP 013-06-0034.

h. 18″ Side Drain Pipe Arch _____

i. 18″ Side Drain Pipe _____

j. 24″ Jacked or Bored Pipe _____

k. 18″ Side Drain with Safety Ends _____

CHAPTER 12 REVIEW QUESTIONS

a. The proposed items of work for Dumplin Creek State Project are found between two Station numbers. What type of sheet(s) has this information? What are the sheet numbers? _____

b. Sheet 3f contains a table titled _____.

c. An Item number listed in the Summary of Estimated Quantities corresponds to the _____.

d. List the three types of Summary Sheets found in a plan set.

_____

e. Does the “Summary of Estimated Quantities” account for the quantities found on the Bridge and Drainage Summary Sheets? _____

f. _____ is usually the first sheet of the Bridge Plans Sheets.

***Note**: Check your responses against answer sheets found at the end of this manual. If you missed MORE than three questions, review this chapter again and correct any wrong answers before progressing.*

TRAINING NOTES

CHAPTER 13

READING the PLANS as a SET

INTRODUCTION

While previous chapters explored each type of plan sheet individually, Chapter 13 contains review questions that reference many of the plan sheets within the Highway Plan Book. The questions are arranged in groups, challenging students to locate the corresponding Plan Sheet from within the Highway Plan Book.

Recall the following information.

- Title Sheets give general location information, and provide indexes to plans.
- Plan and Profile Sheets provide additional location data using plan and profile views.
- Typical Section and Details Sheets along with Special Detail Sheets show details of construction for the highway, and various structural items.
- Special Details cover construction items that are NOT typical, yet specific to the individual project.
- The Summary of Estimated Quantities Sheets, Plan and Profile Sheets, Existing and Design Drainage Maps, and Standard Plan Sheets are all sources for Drainage information.
- Soil information is found on several sheets, such as Subgrade Soil Survey Sheet, or Bridge Sheets (Boring and Test Pile Data).
- Bridge Plan Sheets, Right-of-Way Sheets along with Plan and Profile Sheets provide Bridge data and construction information.
- Cross-Section Sheets include subgrade construction data.
- Title Sheets along with Plan and Profile Sheets show the location, length and finished elevations of a bridge.

Remember, when looking for information within the Plan Set; refer to the sheets in this order:

1) Use the indexes first,
2) then, plan and profile views
3) then, sheets showing details of construction

Read the following questions carefully. Some will designate the use of a particular State Project or Plan Sheet, while others necessitate finding the sheet within the Highway Plan Book to answer the question correctly.

HIGHWAYS

13-1. **General Information.**

Consider State Project H. 000238 (Drain Canal). Fill in the blanks with the correct answer.

a. Record the name of this project. _____

b. What parish is designated for this proposed project? _____

c. Record the Highway designated for this proposed project. _____

d. How many bridge sites are proposed? _____

e. Record the beginning and ending station numbers for each bridge site.

begin _____ end _____

begin _____ end _____

f. What is the total proposed length for State Project H. 000238?

_____

g. The proposed bridge(s) are to be constructed over _____

13-2. Consider State Project H. 002575 (Claiborne). Fill in the blanks with the correct data regarding the **HORIZONTAL CURVE** located on LA 518 beginning at Station 119 + 65.39.

a. Is this a left or right turning curve? _____

b. The point of curvature is located at station _____.

c. The point of intersection is located at station _____.

13-2. *(continued)*

d. What is the distance between the Point of Curvature and the Point of Intersection? _____

e. The Point of Tangency is located at station _____.

f. Is the Point of Intersection on the roadway centerline?_____

g. After the curve, what is the bearing of the tangent segment? _____

h. What is the bearing change between the tangent segments? _____

i. Before the curve, what is the bearing of the tangent segment? _____

j. The length of curvature is _____.

k. The radius of the curve is _____.

13-3. Consider State Project H. 002575 (Claiborne), fill in the blanks with the correct data for the **VERTICAL CURVE** located on LA 518 beginning at Station 110 + 00.00.

a. What is the highway grade before the curve? _____

b. The point of vertical curvature is located at station _____.

c. The point of vertical intersection is located at station _____.

d. The point of vertical tangency is located at station _____.

e. The horizontal length of the curve is _____.

f. The elevation at the point of intersection is _____.

g. The highway grade after the curve is _____.

h. Is this curve a crest of a hill or a dip in the land?_____

13-4. Consider State Project 268-01-0012 (Dumplin Creek).
Fill in the blanks with the correct information regarding the Design Drainage component located on LA 447 at Station 122 + 45.

a. What kind (type) of drainage feature is proposed? _____

b. What is the Structure number? _____

c. What is the Head Water elevation? _____

d. What is the Tail Water elevation? _____

e. What is the length of this drainage structure? _____

f. List the two possible proposed structure size(s) and type(s).

_____ or _____

g. Record the amount of drainage area this drainage structure controls.

_____

13-5. Consider State Project 024-06-0036, Bayou Zourie Bridge Replacement on US 171, fill in the blanks with the correct data.

a. What is the centerline elevation of the existing roadway at Station 114 + 00.00? _____

b. What is the amount of general excavation between Stations 114 + 00.00 and 118+ 00.00? _____

c. What is the amount of embankment between these two stations? _____

d. Is this 400 feet considered a cut section or a fill section? _____

e. What is the finish grade elevation of the roadway centerline at Station 122 + 35.00? _____

13-6. Consider the Typical Sections found on State Project H.008244 (Plaquemines).

a. What is the slope of the subgrade at Station 32 + 22.00? _____

b. What is the slope of the right shoulder at Station 50 + 23.51? _____

c. What is the slope of the backslope at Station 52 + 22.00? _____

d. What is the width at the bottom of the right ditch at Station 52 + 22.00?

_____

e. Describe this symbol △ (as written on this Typ. Sec. & Detail Sheet)

_____

f. How thick is the base course at Station 50 + 23.51? _____

g. How thick is the Superpave Asphaltic Concrete Wearing Level 1 at Station 10 + 78.50? _____

13-7. Consider SP 268-01-0012 (Dumplin Creek). Fill in the blanks with the correct answers.

a. Refer to the Typical Grading Section at Station 140 + 00. What appears on the subgrade 7′ to the left of the centerline? _____

b. What is the slope of the concrete walk at Station 112 + 71.00?_____

c. How wide is the concrete walk at Station 140 + 00?_____

d. Describe ⑥ at Station 140 + 00. _____

e. Describe ⑤ on Sheet 2a. _____

f. What is the thickness of the asphaltic concrete base course? _____

g. What is the thickness of the subgrade layer at Station 112 + 17? _____

13-8. **a**. How many square yards of Portland Cement Concrete Pavement (12" thick) are required between Stations 112 + 15.01 and 112 + 95.47 on SP 268-01-0012 (Dumplin Creek)? _____

b. What is the width of the base course at this location? _____

13-9. Fill in the blanks with the correct answers using the Summary of Estimated Quantities for SP H.000238 (Drain Canal).

a. How many square yards of Flexible Revetment are required? _____
b. What is the item number for catch basins? _____
c. How large is the area requiring Hydro-seeding? _____
d. How many linear feet of 18" side drain pipe *(PP/CMP, Bridge Pipe)* is required?_____
e. How many square yards of Item 725-01-00100 are required?_____
f. Item 202-02-2630 refers to _____.
g. How many linear feet of blocked out guardrail will be used on this project? _____

13-10. Consider SP H.000238 (Drain Canal).

a. What Sheets contain Traffic Control Plans? _____
b. What Sheets contain Construction Signing for Site 2? _____
c. What kind of plan is CB 01?_____

13-11. Consider SP 268-01-0012 (Dumplin Creek). Fill in the blanks with the correct information regarding the drainage structures required at the following locations.

	Diameter	Length
a. STA. 112 + 59	_____	_____
b. STA. 125 + 45	_____	_____
c. STA. 111 + 89.5	_____	_____

13-12. Consider SP 268-01-0012 (Dumplin Creek). Fill in the blanks with the correct information relating to the required drainage structure at Station 132 + 10.69.

a. Type of structure: _____
b. Size (dia): _____
c. Length: _____

BRIDGES

13-13. Consider SP H.000238 (Drain Canal). Fill in the blanks regarding the structure found at Station 110 + 07.77.

a. What is the length of this structure? _____

b. How wide is the approach slab on the west side of this structure?_____

c. How many westbound spans does this structure have? _____

d. What is the length of each span? _____

e. What is the vehicle design speed for this structure? _____

13-14. Consider SP H.000238. What is the total amount of concrete necessary for both Approach Slabs? _____

13-15. Consider SP H.000238. Fill in the blanks with the correct information regarding the reinforcement steel (rebar) requirements for one approach slab.

		Number of Bars	Total Length
a.	Bar 701	_____	_____
b.	Bar 703	_____	_____
c.	Bar 402	_____	_____
d.	Bar 408	_____	_____

13-16. Consider SP H.000238. What is the grade *(slope)* between Station 210 + 01.97 and Station 210 + 40.72? _____

13-17. Consider Control Point # 3 at Station 220 + 90.49 on SP H.000238. What is the distance from the IP *(iron rod)* to the .20 Metal Fence Corner? _____

13-18. Consider SP H.000238. What is the width of the Travel Lanes between Stations 106 + 41.00 and 110 + 07.77? _____

13-19. Consider SP H.000238. How many “phases” are referred to on the sheet titled “Suggested Sequence of Construction” for Site 1? _____

13-20. Consider SP H.000238. Answer the following questions concerning Bent No. 2 at Site 1 (westbound lanes.)

a. How many piles are required for this bent? _____

b. What is the diameter of the piles? _____

13-21. Consider SP H.000238. What is the total amount of piles associated with Site 1?

_____

13-22. Consider the Barrier Rail Details (BR-02) for SP 268-01-0012 (Dumplin Creek). What is the sheet number that contains the information necessary to determine if they have been modified for this project? _____

13-23. Consider SP 268-01-0012. What standard plan is used to describe the concrete piles for this project? _____

13-24. Consider the pile sizes used in SP 268-01-0012. What is the weight per linear foot? _____

13-25. Consider SP 268-01-0012. List the Station numbers for Boring sites 1 and 2.

a. Site 1. _____

b. Site 2. _____

This concludes Highway Plan Reading II, the second part of the Highway Plan Reading course. Students successfully completing this course have the tools necessary to accurately read, identify, and interpret the components found within a set of Highway Plans.

TRAINING NOTES

APPENDIX A

Definitions

Approach slab	A slab of concrete connecting a roadway to a bridge.
Average Daily Traffic (ADT)	The total traffic volume during a given time period divided by the number of days in the period.
Base Course	The layer or layers of specified material of design thickness, constructed on the subgrade to support a surface course.
Base Line	The North-South Dividing line used as a reference for township line numbers. There is one *base line* used in Louisiana
Bearing Number	Indicates the direction of a line. (e.g. a centerline, side of a parcel, etc.)
Bench Mark	A permanent point (monument) of known elevation
Bent	The *bent* is the supporting structure for the bridge. The two major parts of the *bent* are the piles and the cap.
Berm	An embankment constructed at both ends of the bridge to provide stabilization of the bridge ends.
Bulkhead	A retaining wall holding back the fill on either side of the approach slab.
Cap	The horizontal support member of the bent. The rest of the bridge structure is built over the *cap*.
Control of Access	The condition where the right of owners or occupants of abutting land or other persons, to access, light, air, or view, in connection with a highway that is controlled by public authority.
Cross-Section View	A view showing the inside of an object as though a piece of the object has been sliced away.
Culvert	Any drainage structure under a roadway or other facility not defined as a bridge.
Delta (Δ)	Indicates the amount of bearing change to the right or left between the two tangent segments of the highway before and after a curve.
Design Drainage Maps	Used to show basic drainage design data including hydrologic information and the design criteria for cross-drain structures. With regard to urban projects, it shows the basic design data for a storm sewer system.

Design Hourly Volume (DHV)	The peak hourly volume of traffic expected in the 30th highest hour during the chosen design year.
Directional Distribution (D)	A measure of the highest traffic volume in one direction during peak hours, expressed as a percentage of DHV
Elevation	The vertical distance of a point above or below a reference surface.
Elevation View	A view showing the height of an object. *Elevations* may be from the front, rear or side views.
Equation	A distance used to relate the difference in length of a section when the station number of a given point is changed for various reasons.
Existing Drainage Maps	A map indicating the size, shape, and direction of flow for all drainage structures affecting drainage with regard to the proposed roadway. It includes the size of all existing drainage structures under all existing roadways and railroads in the vicinity.
Grade	The slope of a land segment.
Invitation to Bid	An advertisement for bids for all work or materials on which bids are required. The advertisement *(invitation to bid)* indicates the location and description of the work as well as the time and place of bid openings.
Length (L)	The length of a curve from the P.C. to the P.T.
Notice to Proceed	Written notice to the contractor to proceed with the contract work, including the date of beginning of contract time.
Parcels	A land area needed for construction, or other purposes.
Piles	The vertical support members of the bent driven into the ground to support the bridge structure.
Plan Change	A general term denoting changes to the contract and implemented by a Plan Change and/or Special Agreement.
Plan Change and/or Special Agreement	A document describing and detailing changes to the contract. It establishes reasons for the changes, specification requirements, method of measurement, basis of payment, etc.

Plans	Contract drawings, showing location, type, dimensions, and other details of the prescribed work.
Plan View	A view from directly above the object, looking down on the object.
Point of Curvature (P.C.)	The point where the tangent (or straight) segment of the highway begins to curve.
Point of Intersection (P.I.)	The point where the extension lines of the tangent segments meet or intersect.
Point of Tangency (P.T.)	The point where the curved segment of the highway ends, and a new tangent segment begins.
Principal Meridian	• The East-West Dividing line used as a reference for range lines. • Louisiana has two Principal Meridians • The Louisiana Principal Meridian is used for that part of the state **west** of the Mississippi River, and the St. Helena Principal Meridian is used for the part of the state **east** of the Mississippi River.
Project Number	A number used to identify a project.
Proposal	The offer of a bidder, on the prescribed form, to perform the stated work and to furnish materials and labor at the prices quoted
Radius (R)	The radius of a curve.
Roadway	The portion of a highway that is improved, designed, or ordinarily used for vehicular travel, exclusive of the shoulder.
Range Lines	Lines drawn parallel to the West-East Dividing line at six-mile intervals.
Right-of-Way	1) As a result of transportation improvement projects, it is at times necessary for the state to acquire private property to expand or improve the existing transportation system. 2) Land and/or property acquired for, or devoted to transportation purposes. 3) Signifies that the Department has the right to pass over the property of others within the limits of construction. 4) Right-of-way is also a project phase.

Section	A division of a township. Most townships are divided into 36 one-mile square sections.
Span	The roadway over the bridge. A span reaches from one side of the bridge to the other and one bent to the next bent.
Special Provisions	Additions and revisions to the standard and supplemental specifications covering conditions applicable to the project.
Specifications	The compilation of provisions and requirements for the performance of prescribed work.
Standard Specifications	A book of specifications for general application and repetitive use.
Station numbers	Used to measure distance along the length of a project. One station represents a distance of 100 feet.
Subgrade	The top surface of a roadbed upon which the pavement structure, shoulders, and curbs are constructed.
Superelevation	A change in the cross slope of a roadway to help cars stay on the highway as they go around curves at high speeds. A curve is *superelevated* when the whole pavement slopes down toward the inside of the curve.
Supplemental Specifications	Additions and revisions to the Standard Specifications.
Surface Course	The top course of the pavement structure.
T	The tangent distance from the P.C. to the P.I., or the P.I. to the P.T. Both distances are the same.
Temporary Bench Mark	A point of known elevation established for temporary use during construction of a project.
Township	An area of land normally 36 square miles
Township Lines	Lines drawn parallel to the North-South Dividing line at six-mile intervals.
Vertical Curve	A parabolic curve connecting the tangent segments of a highway in the “up and down” or vertical direction.

APPENDIX B

Chapter Answers

CHAPTER 7 – ANSWERS

7-1.

a. 254 + 11	**c**. 366.7 CY	**e**. N 79° 34′ 00″ E	**g.** 24′ wide gravel road
b. 76.8 CY	**d**. 120.18 LF	**f**. 74.28′	

7-2.

a. 253 + 56.88	**b**. 49′	**c**. 97° 45′	**d**. 24′

7-3.

a. 1-½ : 1	**d**. varies	**g**. varies	**j**. varies
b. R/W	**e**. 2′-3′	**h**. varies	
c. varies	**f**. yes	**i**. 2′-3′	

7-4.

a. 15′	**b**. property owners	**c**. turned around

7-5.

a. 1223′	**b**. 1792′	**c**. 166 + 60	**d**. 104 + 64

Chapter 7 Review Question Answers

a. draining, R/W	**c**. outside	**e**. outside	**g**. not typical, yet specific
b. water for irrigation purposes	**d**. to turn farm machinery around	**f**. side roads	

CHAPTER 8 – ANSWERS

8-1. **a**. West to East **b**. Drainage

8-2. No answer required

8-3.

a. 18″ X 81′	**b**. C.P. side drain	**c**. D.A. = 1.5 acres	**d**. 31.60′

8-4.

a. corrugated metal	**c**. 18″	**e**. arch
b. 36″	**d**. 50′	**f**. side to side at the widest point

8-5. No answer required

8-6.

a. 18 acres	**b**. 35.78′	**c**. from the west

8-7. No answer required

8-8.

a. 30″ RCPA or 36″ CMPA	**c**. 10.5 inches	**e**. West to East	**g**. *not classified as a* bridge providing an opening under the roadway.
b. 42.18′	**d**. 41.80′	**f**. 1 acre	

8-9. No answer required

Chapter 8 Review Question Answers

a. natural drainage flow	**e**. Reinforced Concrete Box culvert	**i**. Invert elevation (flow line elev.)	**m**. span
b. 18 acres	**f**. Corrugated Metal Pipe Arch	**j**. Corrugated Metal Pipe	**n**. inside
c. west to east	**g**. Drainage Area	**k**. Design Drainage	**o**. minimize
d. B	**h**. Reinforced Concrete Pipe	**l**. Existing Drainage	**p**. Hydrologic Summary Table

CHAPTER 9 – ANSWERS

9-1.

a. >10′	**d**. 2, 4	**g**. Sample Legend	**i**. Shelly Sandy Loam Plasticity Index Hot Mix
b. 5′	**e**. 3	**h**. Scale	
c. 5′	**f**. Legend		

9-2.

a. Sample Legend	**b**. Lower A group numbers

9-3.

a. STA. 695 + 00 EB	**c**. No	**e**. Yes
b. A-6 (7)	**d**. Yes	

9-4.

a. Stiff Red Brown, Red Silty Clay	**c**. 38	**e**. 0, 0, 2, 29	**g**. No
b. A-6 (10)	**d**. 24	**f**. 26%	**h**. STA. 680 + 00 EB

9-5.

a. 8′	**c**. 3	**e**. A-7-6 (24)	**g**. 30
b. 2′	**d**. Stiff Red RN. LT. Silty Clay	**f**. 47	

9-6.

a. 5′	**c**. Soft Red Brn. Silty Loam	**e**. non-plastic (NP)
b. Yes	**d**. A-4 (0)	

9-7. 25′

Chapter 9 Review Question Answers

9-8.

a. 1.5′	**c**. 1	**e**. A-2-4 (0)
b. 6.0′	**d**. Soft Gr. Brn. Silty Loam	**f**. non-plastic (NP)

9-9.

a. Plasticity Index	**d**. Soil Group	**g**. suitable or select material
b. Liquid Limit	**e**. Soil sample #	**h**. unsuitable or non-select material
c. Non-plastic	**f**. Silty Loam	

9-10

a. Low number	**b**. Low number	**c**. Low number	**d**. Low number

9-11. Organic Material or Unsuitable Material

9-12. District Laboratory Engineer

CHAPTER 10 – ANSWERS

10-1. No answer required

10-2. No answer required

10-3. No answer required

10-4. No answer required

10-5. No answer required

10-6.

a, b. Top Slab, Bottom Slab or the 2 Side walls	**c, d, e.** Toe wall, Footing, Parapet and 2 Wing walls

10-7. No answer required

10-8. No answer required

10-9. No answer required

10-10.

a. Toe wall and footing	**b**. Barrel sidewalls	**c**. Parapet

10-11. No answer required

10-12. No answer required

10-13. No answer required

10-14.

a. $7\ 1/2''$	**c**. 6″ *(look at the Section thru Barrel drawing)*	**e**. $1\ 13/16''$
b. $7\ 1/2''$	**d**. 5″	**f**. Opening or 5′

10-15.

a. **E** ⟶ 1′-5″	**b**. 8″ + **J** = 8″ + 1′-2″ = 1′-10″	**c**. **G** ⟶ 1′-5″ + 1′-10″ = 3′-3″

10-16.

a. H = 6′- $7\ 1/2''$	**b**. M = 34′- 0″	**c**. P = 11′- 3″	**d**. L = 11′- 9″

10-17.

a. 8667 total lbs.	**c**. 66.64 total CY
b. 170.27 lbs. per LF	**d**. 1.1862 CY per LF

10-18. No answer required

CHAPTER 10 – ANSWERS *(continued)*

10-19. No answer required

10-20. No answer required

10-21.

a. #4 or $^1/_2$″	**c**. 7′ - 0″
b. 330	**d**. 10″ O.C.

10-22.

a. Parapet	**c**. small wing walls attached to barrel sides
b. Toe wall/footing	**d**. Wing wall

10-23.

	Size	No.	Length	Spacing
a.	#6	78	20′ – 6″	14” O.C.
b.	#6	156	5′ – 2″	14” O.C.
c.	#6	80	21′ – 1″	14” O.C.
d.	#4	220	7′ – 0″	10” O.C.

10-24.

	Joints between the:	Bar letter	Size
a.	top slab and barrel walls	D	#4
b.	barrel walls and bottom slab	D	#4
c.	toe walls and wing walls	E	#4
d.	wing-walls and the small wings extending from the barrel side walls	X	#6
e.	wing-walls and parapet	X	#6
f.	toewall and the small wings extending from the barrel side walls	E	#4
g.	parapet and barrel top slab	N	#4

10-25. **a**. 4 **b**. Parapet

10-26. **a**. the End Elevation and Section A-A

10-27. No answer required

10-28. No answer required

10-29.

a. $^1/_2$″	**b**. 2 $^3/_4$″ + $^1/_2$″ + $^1/_2$″	**c**. 2 $^3/_4$″	**d**. 1 $^5/_8$″	**e**. $^1/_4$″

CHAPTER 10 – ANSWERS *(continued)*

10-30. No answer required

10-31.

a. 75°	**e**. 17′	**i**. 65.31 lbs.	**m**. Size: #6 Number: 192 Length: 7′- 6″ Spacing: 5 **1/2**″ O.C.
b. No	**f**. Parapet	**j**. T = 8″ and Y = 1 7/8″	
c. **L_1** = distance from the inside of the barrel wall to the end of the wing-wall on the left side *(see the left side of the End Elevation, sheet 205)*	**g**. Class A	**k**. 6′	
d. the Height of the Headwall (**H**) is found on the End Elevation, Section B-B, Section C-C, & the Bill of Reinforcing Steel for 44′ Culvert	**h**. 37.55 CY	**l**. **1/3** of H	

10-32.

a. Drop Inlet	**c**. 4	**e**. Corners	**g**. heavy asphalt
b. Catch Basin	**d**. welded	**f**. Grate Seat	

10-33.

a. 7″	**c**. where no pedestrian traffic is expected	**e**. 9 3/4 ″ 10 1/2 ″ 10 1/2 ″ 9 3/4 ″	**g**. Yes *(see note on sheet 202 about cutting the reinforcing steel)*
b. 3′- 0″ x 2′- 0 1/4 ″	**d**. #4	**f**. 9 3/4 ″ 9 ″ 9 3/4 ″	

10-34. **36″** *(see title block on sheet 305)*

CHAPTER 10 – ANSWERS *(continued)*

10-35.

a. $^1/_2$ ″	**c**. Round	**e**. 2′- 0″ lap req'd.
b. 9′- 7″	**d**. 1′- 2 $^1/_2$ ″	

10-36.

a. **if V = 78″**

$$\textbf{Number of Bars} = \frac{(V + 3'')}{9''} + 1$$

$$\textbf{Number of Bars} = \frac{(78 + 3'')}{9''} + 1$$

$$\textbf{Number of Bars} = \frac{81}{9} + 1$$

Number of Bars = 9 + 1 = 10

Number of Bars = **10**

c. 1′- 10″

b. **if V = 24 ″**

$$\textbf{Number of Bars} = \frac{(V + 3'')}{9''} + 1$$

$$\textbf{Number of Bars} = \frac{(24 + 3'')}{9''} + 1$$

$$\textbf{Number of Bars} = \frac{27}{9} + 1$$

Number of Bars = 3 + 1 = 4

Number of Bars = **4**

d. 8″

10-37.

a. aluminum and galvanized steel	**f**. 5′	**k**. 500′
b. 22 #	**g**. 13 ½ or 15 ½ gauge	**l**. 11”
c. 15 #	**h**. 10′- 0″ O.C.	**m**. 49″
d. 8′- 0″	**i**. 4″	**n**. away from the highway
e. 7′- 0″	**j**. at every post	

CHAPTER 10 – ANSWERS *(continued)*

10-38.

a. shoulder edges	**e**. 4″
b. to form the end wall on slopes	**f**. 14″
c. double row of sacks with Geo-textile fabric	**g**. stabilization
d. above	

10-39. No answer required

10-40.

a. detour 100 ft. sign Intended use: Warning Location: in advance of a point at which traffic is diverted Colors: Orange and Black Size: 48″ x 48″ Code number: W20-2	**c. Flagman 500 feet ahead sign** Intended use: Warning Location: advance of any point which a flagger has been stationed to control traffic Colors: Orange and Black Size: 36″ x 36″ Code number: W20-7
b. detour arrow sign Intended use: Warning Location: only at the point where a detour roadway or route has been established Colors: Background – Black Arrow – Orange Legend – Black Size: 48″ x 18″ Code number: M4 – 10R M4 – 10L	**d. one way arrow sign** Intended use: Regulatory Location: on street to indicate traffic direction Colors: Background – Black Arrow – White Legend - Black Size: 36″ x 12″ Code number: R6 – 1L R6 – 1R

CHAPTER 10 – ANSWERS *(continued)*

10-40. *(cont.)*

e. Soft shoulder sign	**f. Speed limit 45 sign**
Intended use: Warning	Intended use: Regulatory
Location: where the project engineer determines that the shoulder of the highway under construction becomes hazardous to traffic	Location: Approximately 750 feet in advance of the point of need, and posted at or just beyond important access points.
Colors: Orange and Black	Colors: Background – White Legend – Black Border – Black
Size: 30″ x 30″	Size: 24″ x 30″ - Standard 48″ x 60″ - Interstate or freeway
Code number: W8-4	Code number: R2-1

CHAPTER 10 – REVIEW QUESTION ANSWERS

Part 1.

a. top slab	**g**. toe-wall	**m**. 3
b. bottom slab	**h**. 3	**n**. pressure
c. side walls	**i**. 2	**o**. barrel side walls
d. parapet	**j**. 1	**p**. straight, flared, U and L
e. wing-walls	**k**. 1	**q**. 4 *(1 per corner)*
f. footing	**l**. 4	**r**. true

Part 2.

a. Barrel	**d**. Headwall
b. Barrel	**e**. Headwall
c. Headwall	**f**. Headwall

Part 3.

	(from sheet 301, 2 opening, 6′ x 4′ culvert)	***Size***	***No.***	***Length***
a.	Bars A	#6	78	14′ - 2″
b.	Bars C	#4	46	47′ - 2″
c.	Bars E	#4	40	7′ - 6″
d.	Bars F	#4	4	11′ - 3″
e.	Bars J	#4	20	7′ - 8″
f.	Bars P	#4	12	9′ - 6″
g.	Bars N	#4	28	4′ - 11″
h.	Bars X	#6	20	2′ - 0″

i. spacing for Bars A = 14″ O.C.

CHAPTER 11 – ANSWERS

11-1. No answer required

11-2. No answer required

11-3.

a. length of the pile	**c**. **energy** required to obtain each foot of **penetration**	**e**. cut - off	**g**. tip elev. calc 61.1- 26.5 = 34.6′ pile length calc 93.5 - 34.6 = 58.9′
b. formula	**d**. diesel, external combustion (steam, air, hydraulic)	**f**. 80.5′	

11-4.

a. 45.71	**d**. 171 + 52.75	**g**. 172 + 12.75	**j**. 20′
b. 60′	**e**. 171 + 72.75	**h**. 172 + 32.75	
c. -14.86	**f**. 171 + 92.75	**i**. 172 + 52.75	

11-5. No answer required

11-6. No answer required

11-7. **a**. Alt Stratas GR Si Sa **b**. Gr Cl

11-8. **a**. qu = .584 Medium Consistency of Clay

11-9.

a. PI = 27	**e**. LL = 56	**i**. Gray	**m**. Sand
b. Moisture = 26	**f**. Blue	**j**. White	**n**. Multiple Shear
c. Sample C65, Boring 1, qu = 4.20, Hard Consistency of Clay	**g**. Black	**k**. Yellow	**o**. Yield
d. Moisture = 26	**h**. Brown	**l**. Clay	**p**. Slickensides

11-10.

a. ½″ wide	**c**. 24′-11 ½″	**e**. 109.90 SY + 109.90 SY = 219.80 SY	**g**. Roadway to the Bridge
b. Preformed Joint Material (Typ)	**d**. 9408 lbs.	**f**. 80 LF	

11-11.

a. 3.50 (DWS elev)	**d**. CB = 4	**g**. North to South	**j**. full depth
b. 2:1 slope	**e**. 55 mph	**h**. 24′ width	**k**. Guardrail Design Standard
c. -10.50 (btm)	**f**. 3 bents	**i**. 38.75′ Ctr. to Ctr.	

11-12. No answer required

11-13.

a. 213 SY	**d**. 147 LF	**g**. 211 + 10.72	**j**. Ton
b. 836.7 LF	**e**. non – standard item	**h**. 247 LF	**k**. Yes, 2126 SY
c. 8	**f**. 116.21	**i**. 673 CY	**l.** 196 LF

11-14.

a. 24″, 30″, 36″	**d**. 6 inches	**g**. W - 4.5	**j**. 12
b. 24 spirals with a pitch of 2″ over a distance of 4′	**e**. 2 inches	**h**. 24″ = 10.5 30″ = 16.5	**k**. 2″ (see the note under Section A-A)
c. ¾″ chamfer	**f**. yes	**i**. 510 lbs./ft.	**l.** 30,980

Chapter 11 Review Questions

a. length	**h**. 160	**o**. pile	**w**. an accident
b. formula	**i**. 16	**p**. cap	**x**. timber piles
c. yes, toward the middle	**j**. one	**q**. berm	**y**. sash and sway
d. piles and a cap	**k**. detailed information	**r**. bulkhead	**z**. *(spiral)* reinforcing steel
e. bent cap	**l**. 5	**s**. span	
f. approach slabs	**m**. 40′	**t**. … from **one edge** of the roadway - to the **opposite edge**	
g. manufactured off site	**n**. false	**u**. … one **bent** to the center of the next **bent**	

CHAPTER 12 – ANSWERS

12-1.

a. There are 9 summary tables on Sheet 3a.

1. Permanent Pavement Markings
2. Concrete Curb
3. Removal of Existing Markings
4. Removal of Guardrail
5. Cold Planing
6. Removal of Curbs
7. Removal of Median/Island
8. Removal of Surfacing and Stabilizes Base
9. Contractor Retained Reclaimed Asphaltic Concrete

b. State Project H. 000238
c. 4002.4 LF
d. 33 CY
e. 208.4 LF
f. 0.090 mile
g. 97.8 SY
h. False

12-2.

a. 40 each	**h**. Square Yard	**o**. 50
b. 712-04-00100	**i**. 1	**p**. Storm Drain Pipe Arch 30″ Eq. RCPA
c. Catch Basins	**j**. MGAL	**q**. 701(02) (E-F)
d. 1656 LF	**k**. 173 MGAL	**r**. 1) 706 (01) (A) 2) 706 (02) (C) 3) 711 (01) (C) 4) 712 (05) 5) 720 (02)) 6) 724 (01 (A)
e. .39 acres	**l**. Ton	**s**. Yes
f. Seeding	**m**. Item	
g. Temp Seeding 215 lbs	**n**. 9595.5 + 573.2 = 10168.7 Tons	

12-3.

a. 140 + 93	**d**. 44′	**g**. 1
b. RCP & RPVCCP_	**e**. 24″	
c. SD PA	**f**. CB-01	

12-4.

a. 30 Years	**e**. 56 + 73	**i**. 178
b. Cross Drain Pipe Arch	**f**. 92 LF	**j**. 165
c. 57	**g**. all Catch Basins and Manholes with dimensions less than or equal to 10 Ft. X 10 Ft. may be precast	**k**. 16
d. 178 LF	**h**. 60	

Chapter 12 Review Question Answers

a. Summary Sheets, 3, 3A – 3E
b. Summary of Estimated Quantities
c. to the numbered sections found in the *Louisiana Standard Specifications for Roads and Bridges*.
d. 1) **Summary Sheets** - usually placed close to the front of the plan set. 2) **Summary of Drainage Structure Sheets** - found among the *Drainage Sheets*. 3) **Bridge Summary Sheets** - found among the *Bridge Plan Sheets*.
e. Yes
f. The Summary of Bridge Quantities Sheet

CHAPTER 13 – ANSWERS

13-1.

a. Drain Canal Bridges on US 90
b. Jefferson
c. US 90
d. 2
e. begin STA. 110 + 08 end STA. 110 + 85 begin STA. 210 + 02 end STA. 210 + 78
f. 0.632 miles
g. Drain Canals

13-2.

a. left	**e**. Station 128 + 65.62	**i**. S 80° 10' 18.0" E
b. Station 119 + 65.39	**f**. No	**j**. 900.23'
c. Station 124 + 18.48	**g**. N 83° 45' 36" E	**k**. 3210.00'
d. 453.09' = T	**h**. 16° 04' 06.2"	

13-3.

a. – 3.10%	**e**. 11500 - 11000 = 500 feet
b. 110 + 00.00	**f**. 256.58'
c. 112 + 50.00	**g**. 0.00%
d. 115 + 00.00	**h**. Dip

13-4.

a. CDPA (see Sheet 46)	**e**. 110'
b. 401	**f**. 2 – 30" RPCA or 2 – 36" CMPA *(PCCSPA is also spec'd)*
c. 34.52	**g**. 18 acres
d. 34.03	

13-5.

a. 205.84'	**d**. FILL
b. 88 CY	**e**. approximately 208.6'
c. 121 CY	

13-6.

a. 2.5%	**e**. "to be constructed free from obstructions"
b. 5.0%	**f**. 8"
c. 3:1	**g**. 2"
d. 4' - 0"	

13-7.

a. crest of the roadway	**e**. Pavement Striping and Reflectorized Markers
b. .05 ft/ft	**f**. 2"
c. 6'	**g**. 2"
d. Pavement Striping	

13-8.

a. 130.6 *(from Sheet 3c)*	**b**. varies

13-9.

a. 2126 SY	**e**. 1693 SY
b. 702 – 03 – 00100	**f**. Removal of Median/Island
c. .39 acres	**g**. 475 LF
d. 247	

13-10.

a. 16 - 22	**b**. 12 - 14	**c**. Standard Plan for Catch Basin

13-11.

	Diameter	Length
a. Sta. 112 + 59	24"	42'
b. Sta. 125 + 45	30"	29'
c. Sta. 111 + 89.5	24"	59'

13-12.

a. Side Drain Pipe *(from Sheet 47)*	**b**. 24"	**c**. 46'

13-13.

a. 77' – 6"	**c**. 2	**e**. 55 *(Site 1)*
b. 20'	**d**. 38' – 9"	

13-14. 439.6 SY *(from Sheets 3b & 102)*

13-15.

		Number of Bars	Total Length
a.	Bar 701	28	674' – 4"
b.	Bar 703	3	72' – 9"
c.	Bar 402	22	540' – 10"
d.	Bar 408	2	45' – 0"

13-16. 0.00 % *(from Sheet 106)*

13-17. 163' *(from Sheet 5)*

13-18. 11' *(from Sheet 4)*

13-19. 4 phases *(from Sheet 6)*

13-20. **a**. 5 piles for Bent #2 at Site 1 **b**. Pile Diameter = 18" *(sheet 104)*

13-21. 33, *(15 piles plus 18 piles, see sheets 103 – 104)*

13-22. Sheet 216

13-23. Sheet 223 is Standard Plan CS - 216

13-24. 14" Solid Piles, 204 lbs. per LF *(from Sheet 223)*

13-25. **a**. STA. 171 + 51.97 **b**. STA. 173 + 03.25

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